# W315/325/345
# Linux User's Manual

**Fourth Edition, July 2009**

***www.moxa.com/product***

© 2009 Moxa Inc. All rights reserved.
Reproduction without permission is prohibited.

# W315/325/345 Linux User's Manual

The software described in this manual is furnished under a license agreement and may be used only in accordance with the terms of that agreement.

## Copyright Notice

Copyright © 2009 Moxa Inc.
All rights reserved.
Reproduction without permission is prohibited.

## Trademarks

MOXA is a registered trademark of Moxa Inc.
All other trademarks or registered marks in this manual belong to their respective manufacturers.

## Disclaimer

Information in this document is subject to change without notice and does not represent a commitment on the part of Moxa.

Moxa provides this document "as is," without warranty of any kind, either expressed or implied, including, but not limited to, its particular purpose. Moxa reserves the right to make improvements and/or changes to this manual, or to the products and/or the programs described in this manual, at any time.

Information provided in this manual is intended to be accurate and reliable. However, Moxa assumes no responsibility for its use, or for any infringements on the rights of third parties that may result from its use.

This product might include unintentional technical or typographical errors. Changes are periodically made to the information herein to correct such errors, and these changes are incorporated into new editions of the publication.

### Technical Support Contact Information
### www.moxa.com/support

Moxa Americas:
Toll-free: 1-888-669-2872
Tel: +1-714-528-6777
Fax: +1-714-528-6778

Moxa China (Shanghai office):
Toll-free: 800-820-5036
Tel: +86-21-5258-9955
Fax: +86-10-6872-3958

Moxa Europe:
Tel: +49-89-3 70 03 99-0
Fax: +49-89-3 70 03 99-99

Moxa Asia-Pacific:
Tel: +886-2-8919-1230
Fax: +886-2-8919-1231

# Table of Contents


**Chapter 1 Introduction ..... 1-1**

Overview ..... 1-2
Software Architecture ..... 1-2
- Journaling Flash File System (JFFS2) ..... 1-3
- Software Package ..... 1-4

**Chapter 2 Getting Started ..... 2-1**

Powering on the W315/325/345 ..... 2-2
Connecting the W315/325/345 to a PC ..... 2-2
- Serial Console ..... 2-2
- Telnet Console ..... 2-3
- SSH Console ..... 2-4

Configuring the Ethernet Interface ..... 2-5
- Modifying Network Settings with the Serial Console ..... 2-6
- Modifying Network Settings over the Network ..... 2-7

GPRS Networks ..... 2-7
- Connecting to a GPRS Network ..... 2-7
- Disconnecting from a GPRS Network ..... 2-8

SD Socket and USB for Storage Expansion ..... 2-8
Test Program—Developing Hello.c ..... 2-8
- Installing the Tool Chain (Linux) ..... 2-9
- Checking the Flash Memory Space ..... 2-9
- Compiling Hello.c ..... 2-10
- Uploading and Running the “Hello” Program ..... 2-11

Developing Your First Application ..... 2-11
- Testing Environment ..... 2-11
- Compiling tcps2.c ..... 2-12
- Uploading and Running the “tcps2-release” Program ..... 2-13
- Summary of the Testing Procedure ..... 2-14

**Chapter 3 Managing Embedded Linux ..... 3-1**

System Version Information ..... 3-2
System Image Backup ..... 3-2
- Upgrading the Firmware ..... 3-2
- Loading Factory Defaults ..... 3-5

Enabling and Disabling Daemons ..... 3-5
Starting a Program Automatically at Run-Level ..... 3-7
Adjusting the System Time ..... 3-8
- Setting the Time Manually ..... 3-8
- NTP Client ..... 3-9
- Updating the Time Automatically ..... 3-9

Cron—Daemon to Execute Scheduled Commands ..... 3-10

**Chapter 4 Managing Communications ..... 4-1**

Telnet / FTP ..... 4-2
DNS ..... 4-2
Web Service—Apache ..... 4-3
Install PHP for Apache Web Server ..... 4-5
IPTABLES ..... 4-7

Observe and erase chain rules ..... 4-9
Define policy for chain rules ..... 4-10
Append or delete rules: ..... 4-10
NAT ..... 4-11
NAT Example ..... 4-12
Enabling NAT at Bootup ..... 4-12
Dial-up Service—PPP ..... 4-13
Example 1: Connecting to a PPP server over a simple dial-up connection ..... 4-13
Example 2: Connecting to a PPP server over a hard-wired link ..... 4-14
How to check the connection ..... 4-15
Setting up a Machine for Incoming PPP Connections ..... 4-16
PPPoE ..... 4-16
GPRS Connection ..... 4-19
Configuring the options for pppd ..... 4-19
Configuring the AT commands ..... 4-20
Example: Selecting the radio band ..... 4-20
NFS (Network File System) ..... 4-21
Setting up the W315/325/345 as an NFS Client ..... 4-21
Mail ..... 4-21
SNMP ..... 4-22
OpenVPN ..... 4-23
Setup 1: Ethernet Bridging for Private Networks on Different Subnets ..... 4-23
Setup 2: Ethernet Bridging for Private Networks on the Same Subnet ..... 4-28
Setup 3: Routed IP ..... 4-28

**Chapter 5 Development Tool Chains ..... 5-1**
Linux Tool Chain ..... 5-2
Steps for Installing the Linux Tool Chain ..... 5-2
Compilation for Applications ..... 5-2
On-Line Debugging with GDB ..... 5-3

**Chapter 6 Programmer's Guide ..... 6-1**
Before Programming Your Embedded System ..... 6-2
Caution Required when Using File Systems ..... 6-2
Using a RAM File System instead of a Flash File System ..... 6-2
Flash Memory Map ..... 6-2
Device API ..... 6-2
RTC (Real Time Clock) ..... 6-3
Buzzer ..... 6-3
WDT (Watch Dog Timer) ..... 6-3
UART ..... 6-6
Relay Output (W345 only) ..... 6-8

**Chapter 7 Software Lock ..... 7-1**

**Appendix A System Commands ..... A-1**
Linux normal command utility collection ..... A-1
File manager ..... A-1
Editor ..... A-1
Network ..... A-1
Process ..... A-2
Other ..... A-2
Moxa special utilities ..... A-2

# 1

# Introduction

The W315/W325/W345 series of wireless RISC-based embedded computers feature a GSM/GPRS module, RS-232/422/485 serial ports, and an Ethernet port in a small, rugged chassis. In addition, the W325 and W345 models come with an SD slot, and the W345 also has two USB 2.0 hosts and one relay output channel.

The W300 series embedded computers are ideal for diverse, machine-to-machine embedded applications. The computers enable the wireless operation of traditionally wired network and serial devices, and can handle transparent data transfer, numeric computing, protocol conversion, data processing, and even data encryption. You will find it easier to build embedded systems for distributed peer-to-peer communication, turn wired devices into wireless devices, and introduce higher mobility and more intelligence to your system. In this chapter, we cover the various capabilities of the W300 series embedded computers.

The following topics are covered in this chapter:

- **Overview**
- **Software Architecture**
  - Journaling Flash File System (JFFS2)
  - Software Package

# Overview

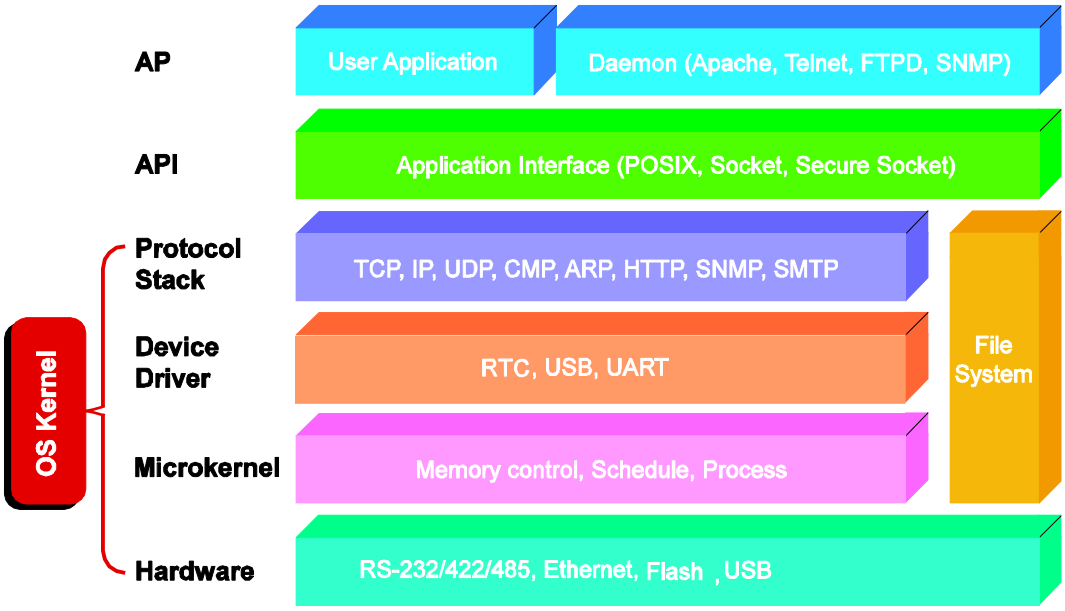
The W315/325/345 wireless embedded computers come with a quad band 850/900/1800/1900 MHz GSM/GPRS module built in to provide long-range communication.

The computers use a Moxa ART 192 Mhz RISC CPU. Unlike the X86 CPU, which uses a CISC design, the RISC architecture and modern semiconductor technology provide these embedded computers with a powerful computing engine and communication functions, but without generating a lot of heat. A 16 MB NOR Flash ROM and on-board SDRAM (64 MB for W345 and 32 MB for W315/325) give you enough memory to install your application software directly on the embedded computer. In addition, a LAN port is built right into the RISC CPU. This network capability, in combination with the ability to control serial devices, makes the W300 Series ideal as communication platforms for data acquisition and industrial control applications.

The pre-installed Linux operating system (OS) provides an open software operating system for your software program development. Software written for desktop PCs can be easily ported to the computer with a GNU cross compiler, without needing to modify the source code. The OS, device drivers (e.g., serial and buzzer control), and your own applications, can all be stored in the NOR Flash.

# Software Architecture

The Linux operating system that is pre-installed in the W315/325/345 follows the standard Linux architecture, making it easy to accept programs that follow the POSIX standard. Program porting is done with the GNU Tool Chain provided by Moxa. In addition to Standard POSIX APIs, device drivers for the USB storage, buzzer and Network controls, and UART are also included with the Linux OS.




The W315/325/345's built-in Flash ROM is partitioned into **Boot Loader**, **Linux Kernel**, **Root File System**, and **User directory** partitions.

In order to prevent user applications from crashing the Root File System, the W315/325/345 comptuers use a specially designed **Root File System with Protected Configuration** for emergency use. This **Root File System** comes with serial and Ethernet communication capability for users to load the **Factory Default Image** file. The user directory saves the user's settings and application.

To improve system reliability, the W315/325/345 has a built-in mechanism that prevents the system from crashing. When the Linux kernel boots up, the kernel will mount the root file system for read only, and then enable services and daemons. During this time, the kernel will start searching for system configuration parameters with ***rc*** or ***inittab***.

Normally, the kernel uses the Root File System to boot up the system. The Root File System is protected, and cannot be changed by the user. This type of setup creates a "safe" zone.

For more information about the memory map and programming, refer to Chapter 6, *Programmer's Guide.*

## Journaling Flash File System (JFFS2)

The Root File System and User directory in the flash memory is formatted with the **Journaling Flash File System (JFFS2)**. The formatting process places a compressed file system in the flash memory. This operation is transparent to the user.

The Journaling Flash File System (JFFS2), which was developed by Axis Communications in Sweden, puts a file system directly on the flash, instead of emulating a block device. It is designed for use on flash-ROM chips and recognizes the special write requirements of a flash-ROM chip. JFFS2 implements wear-leveling to extend the life of the flash disk, and stores the flash directory structure in the RAM. A log-structured file system is maintained at all times. The system is always consistent, even if it encounters crashes or improper power-downs, and does not require fsck (file system check) on boot-up.

JFFS2 is the newest version of JFFS. It provides improved wear-leveling and garbage-collection performance, improved RAM footprint and response to system-memory pressure, improved concurrency and support for suspending flash erases, marking of bad sectors with continued use of the remaining good sectors (enhancing the write-life of the devices), native data compression inside the file system design, and support for hard links.

The key features of JFFS2 are:

- Targets the Flash ROM Directly
- Robustness
- Consistency across power failures
- No integrity scan (fsck) is required at boot time after normal or abnormal shutdown
- Explicit wear leveling
- Transparent compression

Although JFFS2 is a journaling file system, this does not preclude the loss of data. The file system will remain in a consistent state across power failures and will always be mountable. However, if the board is powered down during a write then the incomplete write will be rolled back on the next boot, but writes that have already been completed will not be affected.

**Additional information about JFFS2 is available at:**

http://sources.redhat.com/jffs2/jffs2.pdf
http://developer.axis.com/software/jffs/
http://www.linux-mtd.infradead.org/

## Software Package

| | |
|---|---|
| **Boot Loader** | Moxa private (V1.2) |
| **Kernel** | Linux 2.6.9 |
| **Protocol Stack** | ARP, PPP, CHAP, PAP, IPv4, ICMP, TCP, UDP, DHCP, FTP, SNMP V1/V3, HTTP, NTP, NFS, SMTP, SSH 1.0/2.0, SSL, Telnet, PPPoE, OpenVPN |
| **File System** | JFFS2, NFS, Ext2, Ext3, VFAT/FAT |
| **OS shell command** | Bash |
| Busybox | Linux normal command utility collection |
| **Utilities** | |
| tinylogin | login and user manager utility |
| telnet | telnet client program |
| ftp | FTP client program |
| smtpclient | email utility |
| scp | Secure file transfer Client Program |
| **Daemons** | |
| pppd | dial in/out over serial port daemon |
| snmpd | snmpd agent daemon |
| telnetd | telnet server daemon |
| inetd | TCP server manager program |
| ftpd | ftp server daemon |
| apache | web server daemon |
| sshd | secure shell server |
| openvpn | virtual private network |
| openssl | open SSL |
| **Linux Tool Chain** | |
| Gcc (V3.3.2) | C/C++ PC Cross Compiler |
| GDB (V5.3) | Source Level Debug Server |
| Glibc (V2.2.5) | POSIX standard C library |

# 2

# Getting Started

In this chapter, we explain how to connect the W315/325/345, how to turn on the power, how to get started programming, and how to use the W315/325/345's other functions.

The following topics are covered in this chapter:

- **Powering on the W315/325/345**
- **Connecting the W315/325/345 to a PC**
  - Serial Console
  - Telnet Console
  - SSH Console
- **Configuring the Ethernet Interface**
  - Modifying Network Settings with the Serial Console
  - Modifying Network Settings over the Network
- **GPRS Networks**
  - Connecting to a GPRS Network
  - Disconnecting from a GPRS Network
- **SD Socket and USB for Storage Expansion**
- **Test Program—Developing Hello.c**
  - Installing the Tool Chain (Linux)
  - Checking the Flash Memory Space
  - Compiling Hello.c
  - Uploading and Running the "Hello" Program
- **Developing Your First Application**
  - Testing Environment
  - Compiling tcps2.c
  - Uploading and Running the "tcps2-release" Program
  - Summary of the Testing Procedure

# Powering on the W315/325/345

Connect the SG wire to the shielded contact located in the upper left corner of the W315/325/345, and then power on the computer by connecting it to the power adaptor. It takes about 30 to 60 seconds for the system to boot up. Once the system is ready, the Ready LED will light up.

NOTE After connecting the W315/325/345 to the power supply, it will take about 30 to 60 seconds for the operating system to boot up. The green Ready LED will not turn on until the operating system is ready.

ATTENTION

This product is intended to be supplied by a Listed Power Unit and output marked with "LPS" and rated 12-48 VDC, 580 mA (minimum requirements).

# Connecting the W315/325/345 to a PC

There are two ways to connect the W315/325/345 to a PC: through the serial console port or by Telnet over the network.

## Serial Console

The serial console gives users a convenient way of connecting to the W315/325/345. This method is particularly useful when using the computer for the first time. The serial console is useful for connecting the W315/325/345 when you do not know either of the two IP addresses.

Use the serial console port settings shown below.

| | |
|---|---|
| **Baudrate** | 115200 bps |
| **Parity** | None |
| **Data bits** | 8 |
| **Stop bit** | 1 |
| **Flow Control** | None |
| **Terminal** | VT100 |

Once the connection is established, the following window will open.

To log in, type the Login name and password as requested. The default values are both **root**:

**Login: root**
**Password: root**

## Telnet Console

If you know at least one of the two IP addresses and netmasks, then you can use Telnet to connect to the W315/325/345's console utility. The default IP address and Netmask for each of the two ports are given below:

| | Default IP Address | Netmask |
|---|---|---|
| **LAN** | 192.168.3.127 | 255.255.255.0 |

Use a cross-over Ethernet cable to connect directly from your PC to the W315/325/345. You should first modify your PC's IP address and netmask so that your PC is on the same subnet as the W315/325/345. For example, if you connect to a LAN, you can set your PC's IP address to 192.168.3.126 and netmask to 255.255.255.0.

To connect to a hub or switch connected to your local LAN, use a straight-through Ethernet cable. The default IP addresses and netmasks are shown above. To log in, type the Login name and password as requested. The default values are both **root**:

**Login: root**
**Password: root**

You can proceed with configuring the network settings of the target computer when you reach the bash command shell. Configuration instructions are given in the next section.

ATTENTION

**Serial Console Reminder**

Remember to choose VT100 as the terminal type. Use the cable CBL-4PINDB9F-150, which comes with the W315/325/345, to connect to the serial console port.

**Telnet Reminder**

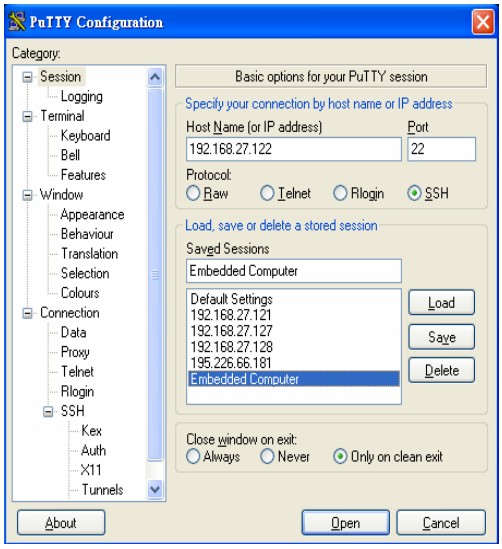
When connecting to the W315/325/345 over a LAN, you must configure your PC's Ethernet IP address to be on the same subnet as the W315/325/345 that you wish to contact. If you do not get connected on the first try, re-check the serial and IP settings, and then unplug and re-plug the power cord.

## SSH Console

The W315/325/345 supports an SSH Console to provide users with better security options.

### Windows Users

Click on the link http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html to download PuTTY (free software) to set up an SSH console for the W315/325/345 in a Windows environment. The following figure shows a simple example of the configuration that is required.




### Linux Users

From a Linux machine, use the "ssh" command to access the W315/325/345's console utility via SSH.

**#ssh 192.168.3.127**

Select yes to complete the connection.

```
 [root@localhost root]# ssh 192.168.3.127
The authenticity of host '192.168.3.127 (192.168.3.127)' can't be established.
RSA key fingerprint is 8b:ee:ff:84:41:25:fc:cd:2a:f2:92:8f:cb:1f:6b:2f.
Are you sure you want to continue connection (yes/no)? yes_
```

| NOTE | SSH provides better security compared to Telnet for accessing the W315/325/345's console utility over the network. |
|---|---|

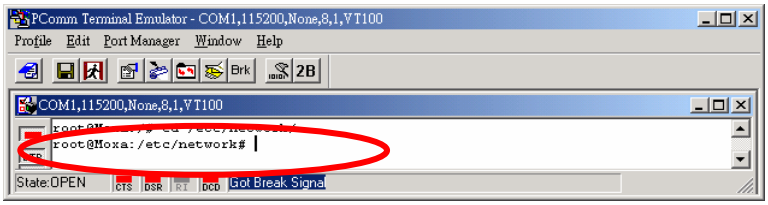
# Configuring the Ethernet Interface

The network settings of the W315/325/345 can be modified with the serial console, or online over the network.

## Modifying Network Settings with the Serial Console

In this section, we use the serial console to configure the network settings of the target computer.

1. Follow the instructions given in a previous section to access the Console Utility of the target computer through the serial console port, and then type **`#cd /etc/network`** to change directories.




2. Type **`#vi interfaces`** to use vi editor to edit the network configuration file. You can configure the Ethernet ports of the W315/325/345 for **static** or **dynamic** (DHCP) IP addresses.

   **Static IP addresses:**

   As shown below, 4 network addresses must be modified: **address**, **network**, **netmask**, and **broadcast**. The default IP addresses are 192.168.3.127 for LAN with default netmask of 255.255.255.0.

   **Dynamic IP addresses:**

   By default, the W315/325/345 is configured for "static" IP addresses. To configure one or both LAN ports to request an IP address dynamically, replace **static** with **dhcp** and then delete the address, network, netmask, and broadcast lines.

| Default Setting for LAN | Dynamic Setting using DHCP |
|---|---|
| iface eth0 inet **static**<br>address 192.168.3.127<br>network: 192.168.3.0<br>netmask 255.255.255.0<br>broadcast 192.168.3.255 | iface eth0 inet **dhcp** |

3. After the boot settings of the LAN interface have been modified, issue the following command to activate the LAN settings immediately:

   **`#/etc/init.d/networking restart`**

NOTE After changing the IP settings, use the **networking restart** command to activate the new IP address.

## Modifying Network Settings over the Network

IP settings can be activated over the network, but the new settings will not be saved to the flash ROM without modifying the **file /etc/network/interfaces**.

For example, type the command **#ifconfig eth0 192.168.1.1** to change the IP address of LAN to 192.168.1.1.

```
root@Moxa:~# ifconfig eth0 192.168.27.125
root@Moxa:~# _
```

# GPRS Networks

W315/325/345 embedded computers include a GSM/GPRS module for wireless communication. The module can be used to transmit data over a GPRS network.

## Connecting to a GPRS Network

Before connecting to a GPRS network, make sure the SIM card is properly installed and the antenna is connected. (Please refer to W315/325/345 Hardware User's Manual for installation details.) Please note the SIM card must be installed when the embedded computer is powered off. The LED indicators on top panel can be used tocheck the signal strength.

NOTE Note that the W315/325/345's GPRS signal strength indicator could indicate a fair or low signal, even if an antenna is NOT connected to the W315/325/345. However, in this case, you will not be able to receive a signal. An antenna must be connected to the W315/325/345 in order to transmit and receive signals.

The W315/325/345 provides a shell script for fast GPRS connection.

1. To make a connection, use the following command:
   **# gprscmd connect**
2. Connecting by GPRS takes only a few seconds. While still connecting, you should see the following message from the command shell:
   **Connecting… Please wait a few seconds.**
3. When the embedded computer has connected successfully to the GPRS network, you should see the message **Connected.**
4. To verify the connection, type:
   **#ifconfig**

The ppp network interface should show up as follows:

```
ppp0   Link encap:Point-Point Protocol
       inet addr:221.120.21.171  P-t-P:192.168.111.111  Mask:255.255.255.255
       UP POINTOPOINT RUNNING NOARP MULTICAST  MTU:1500  Metric:1
       RX packets:20 errors:0 dropped:0 overruns:0 frame:0
       TX packets:21 errors:0 dropped:0 overruns:0 carrier:0
       collisions:0 txqueuelen:3
       RX bytes:954 (954.0 B)  TX bytes:779 (779.0 B)
```

## Disconnecting from a GPRS Network

To disconnect from the GPRS network, type

**#gprscmd disconnect**

After a few seconds, the embedded computer will disconnect from the GPRS network. A notification message will NOT be shown.

NOTE The **gprscmd** command provides a fast interface for users to connect to the GPRS network using Point-to-Point Protocol (PPP). If you are an advanced user, and you want to configure your own connection settings, please refer to the **GPRS Connection** section in Chapter 4.

# SD Socket and USB for Storage Expansion

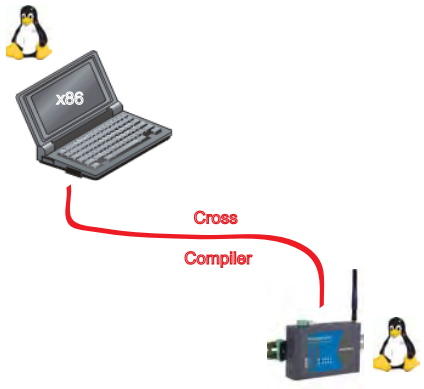
The W315/325/345 models have an SD socket for storage expansion. The SD slot allows users to plug in a Secure Digital (SD) memory card compliant with the SD 1.0 standard for up to 1 GB of additional memory space, or a Secure Digital High Capacity (SDHC) memory card compliant with the SD 2.0 standard for up to 16 GB of additional memory space. Please refer to the W315/325/345 Hardware User's Manual to see how to install the SD card.

After installing an SD card, the SD card will be mounted at **/mnt/sd**.

In addition to the SD socket, a USB 2.0 host is located on the front panel. The USB host is also designed for storage expansion. To expand the amount of storage with a USB flash disk, you just need to plug the USB flash disk into this USB port. The flash disk will be detected automatically, and its file partition will be mounted into the OS. The USB storage device will be mounted in one of the following four directories: **/mnt/usbstorage1**, **/mnt/usbstorage2**, **/mnt/usbstorage3**, or **/mnt/usbstorage4**.

# Test Program—Developing Hello.c

In this section, we use the standard "Hello" programming example to illustrate how to develop a program for the W315/325/345. In general, program development involves the following seven steps.




**Step 1:**
Connect the W315/325/345 to a Linux PC.
**Step 2:**
Install Tool Chain (GNU ross Compiler & glibc).
**Step 3:**
Set the cross compiler and glibc environment variables.
**Step 4:**
Code and compile the program.
**Step 5:**
Download the program to the W315/325/345 via FTP or NFS.
**Step 6:**
Debug the program
→ If bugs are found, return to Step 4.
→ If no bugs are found, continue with Step 7.
**Step 7:**
Back up the user directory (distribute the program to additional W315/325/345 units if needed).

## Installing the Tool Chain (Linux)

The Linux Operating System must be pre-installed in the PC before installing the W315/325/345 GNU Tool Chain. Fedora core or compatible versions are recommended. The Tool Chain requires approximately200 MB of hard disk space on your PC. The W315/325/345 Tool Chain software is located on the W315/325/345 CD. To install the Tool Chain, insert the CD in your PC and then issue the following commands:

**#mount /dev/cdrom /mnt/cdrom**
**#sh /mnt/cdrom/tool-chain/linux/install.sh**

The Tool Chain will be installed automatically on your Linux PC within a few minutes. Before compiling the program, be sure to set the following path first, since the Tool Chain files, including the compiler, link, library, and include files are located in this directory.

**PATH=/usr/local/arm-linux/bin:$PATH**

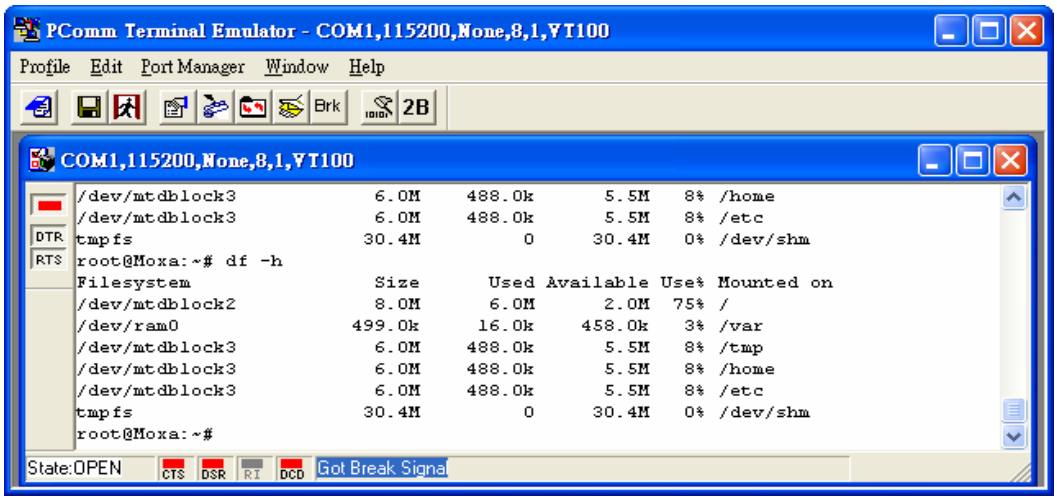
Setting the path allows you to run the compiler from any directory.

NOTE Refer to Appendix B for an introduction to the Windows Tool Chain. In this chapter, we use the Linux tool chain to illustrate the cross compiling process.

## Checking the Flash Memory Space

If the flash memory is full, you will not be able to save data to the Flash ROM. Use the following command to calculate the amount of "Available" flash memory:

**/>df –h**




If there isn't enough "Available" space for your application, you will need to delete some existing files. To do this, connect your PC to the W315/325/345 with the console cable, and then use the console utility to delete the files from the W315/325/345's flash memory. To check the amount of free space available, look at the directories in the read/write directory **/dev/mtdblock3**. Note that the directories /**home** and /**etc** are both mounted in the directory **/dev/mtdblock3**.

NOTE If the flash memory is full, you will need to free up some memory space before saving files to the Flash ROM.

You can ONLY write files in **/home, /tmp, /etc, /var** directories. Files in **/var** directory will not be kept after reboot. Users are not allowed to have write privilege in other directories, including the directory **/root**.

## Compiling Hello.c

The package CD contains several example programs. Here we use **Hello.c** as an example to show you how to compile and run your applications. Type the following commands from your PC to copy the files used for this example from the CD to your computer's hard drive:

**# cd /tmp/**
**# mkdir example**
**# cp –r /mnt/cdrom/example/* /tmp/example**

To compile the program, go to the Hello subdirectory and issue the following commands:

**#cd example/hello**
**#make**

You should receive the following response:

```
[root@localhost hello]# make
/usr/local/arm-linux/bin/arm-linux-gcc –o hello-release hello.c
/usr/local/arm-linux/bin/arm-linux-strip –s hello-release
/usr/local/arm-linux/bin/arm-linux-gcc –ggdb -o hello-debug hello.c
[root@localhost hello]# _
```

Next, execute hello.exe to generate **hello-release** and **hello-debug**, which are described below:

**hello-release**—an ARM platform execution file (created specifically to run on the W315/325/345)

**hello-debug**—an ARM platform GDB debug server execution file (see Chapter 5 for details about the GDB debug tool).

NOTE Since Moxa's tool chain places a specially designed **Makefile** in the directory **/tmp/example/hello**, be sure to type the **#make** command from within that directory. This special Makefile uses the arm-linux-gcc compiler to compile the hello.c source code for the Xscale environment. If you type the **#make** command from within any other directory, Linux will use the x86 compiler (for example, cc or gcc).

Refer to Chapter 5 to see a Makefile example.

## Uploading and Running the "Hello" Program

Use the following commands to upload **hello-release** to the W315/325/345 via FTP.

1. From the PC, type:

```
#ftp 192.168.3.127
```

2. Use the bin command to set the transfer mode to Binary mode, and then use the put command to initiate the file transfer:

```
ftp> bin
ftp> put hello-release
```

3. From the W315/325/345, type:

```
# chmod +x hello-release
# ./hello-release
```

The word **Hello** will be printed on the screen.

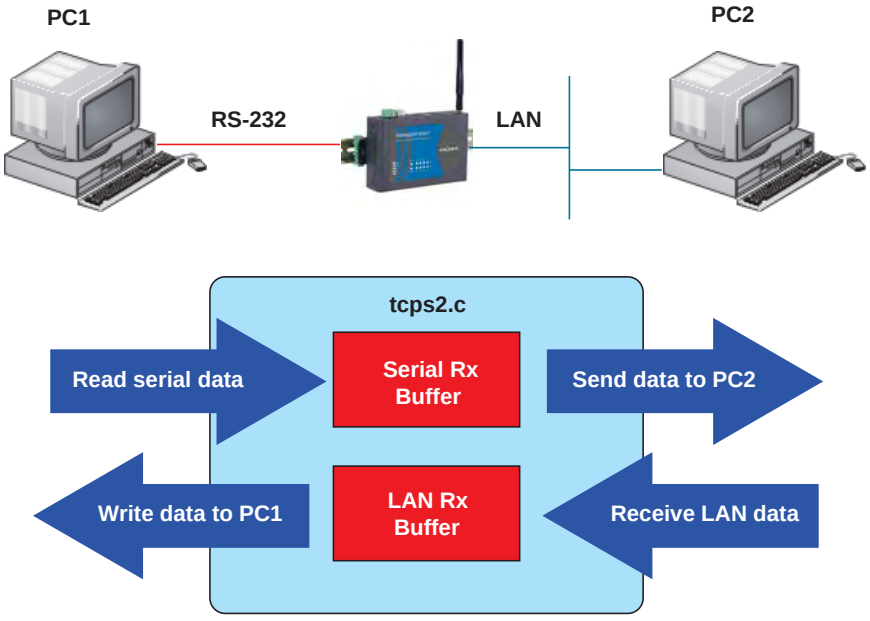
```
root@Moxa:~# ./hello-release
Hello
```

# Developing Your First Application

We use the tcps2 example to illustrate how to build an application. The procedure outlined in the following subsections will show you how to build a TCP server program plus serial port communication that runs on the W315/325/345.

## Testing Environment

The tcps2 example demonstrates a simple application program that delivers transparent, bi-directional data transmission between the W315/325/345's serial and Ethernet ports. As illustrated in the following figure, the purpose of this application is to transfer data between PC 1 and the W315/325/345 through an RS-232 connection. At the remote site, data can be transferred between the W315/325/345's Ethernet port and PC 2 over an Ethernet connection.



## Compiling tcps2.c

The source code for the tcps2 example is located on the CD-ROM at **CD-ROM://example/TCPServer2/tcps2.c.** Use the following commands to copy the file to a specific directory on your PC. We use the direrctory **/home/w3x5/1st_application/**. Note that you need to copy 3 files—Makefile, tcps2.c, tcpsp.c—from the CD-ROM to the target directory.

**#mount –t iso9660 /dev/cdrom /mnt/cdrom**
**#cp /mnt/cdrom/example/TCPServer2/tcps2.c /home/w3x5/1st_application/tcps2.c**
**#cp /mnt/cdrom/example/TCPServer2/tcpsp.c /home/w3x5/1st_application/tcpsp.c**
**#cp /mnt/cdrom/example/TCPServer2/Makefile /home/w3x5/1st_application/Makefile**

Type **#make** to compile the example code:

You will get the following response, indicating that the example program was compiled successfully.

```
root@server11:/home/w3x5/1st_application
[root@server11 1st_application]# pwd
/home/w3x5/1st_application
[root@server11 1st_application]# 11
total 20
-rw-r--r--  1 root root  514 Nov 27 11:52 Makefile
-rw-r--r--  1 root root 4554 Nov 27 11:52 tcps2.c
-rw-r--r--  1 root root 6164 Nov 27 11:55 tcps2.c
[root@server11 1st_application]# make_
/usr/local/arm-linux/bin/arm-linux-gcc -o tcps2-release tcps2.c
/usr/local/arm-linux/bin/arm-linux-strip –s tcps2-release
/usr/local/arm-linux/bin/arm-linux-gcc -o tcpsp-release tcpsp.c
/usr/local/arm-linux/bin/arm-linux-strip –s tcpsp-release
/usr/local/arm-linux/bin/arm-linux-gcc –ggdb -o tcps2-debug tcps2.c
/usr/local/arm-linux/bin/arm-linux-gcc –ggdb -o tcpsp-debug tcpsp.c
[root@server11 1st_application]# 11
total 92
-rw-r--r--  1 root root   514  Nov 27 11:52 Makefile
-rwxr-xr-x  1 root root 25843 Nov 27 12:03 tcps2-debug
-rwxr-xr-x  1 root root  4996  Nov 27 12:03 tcps2-release
-rw-r--r--  1 root root  4554  Nov 27 11:52 tcps2.c
-rwxr-xr-x  1 root root 26823 Nov 27 12:03 tcpsp-debug
-rwxr-xr-x  1 root root  5396  Nov 27 12:03 tcpsp-release
-rw-r--r--  1 root root  6164  Nov 27 11:55 tcpsp.c
[root@server11 1st_application]#
```

Two executable files, tcps2-release and tcps2-debug, are created.

**tcps2-release**—an ARM platform execution file (created specifically to run on the W315/325/345)

**tcps2-debug**—an ARM platform GDB debug server execution file (see Chapter 5 for details about the GDB debug tool).

NOTE If you get an error message at this point, it could be because you neglected to put tcps2.c and tcpsp.c in the same directory. The example Makefile we provide is set up to compile both tcps2 and tcpsp into the same project Makefile. Alternatively, you could modify the Makefile to suit your particular requirements.

## Uploading and Running the "tcps2-release" Program

Use the following commands to use FTP to upload **tcps2-release** to the W315/325/345.

1. From the PC, type:

```
#ftp 192.168.3.127
```

2. Next, use the **bin** command to set the transfer mode to **Binary**, and the **put** command to initiate the file transfer:

```
ftp> bin
ftp> cd home
ftp> put tcps2-release
```

```
root@server11:/home/w3x5/1st_application
[root@server11 1st_application]# ftp 192.168.3.127
Connected to 192.168.3.127
220 Moxa FTP server (Version wu-2.6.1(2) Mon Nov 24 12:17:04 CST 2003) ready.
530 Please login with USER and PASS.
530 Please login with USER and PASS.
KERBEROS_V4 rejected as an authentication type
Name (192.168.3.127:root): root
331 Password required for root.
Password:
230 User root logged in.
Remote system type is UNIX.
Using binary mode to transfer files.
ftp> bin
200 Type set to I.
ftp> put tcps2-release
local: tcps2-release remote: tcps2-release
277 Entering Passive Mode (192.168.3.127.82.253)
150 Opening BINARY mode data connection for tcps2-release.
226 Transfer complete
4996 bytes sent in 0.00013 seconds (3.9e+04 Kbytes/s)
ftp> ls
227 Entering Passive Mode (192.168.3.127.106.196)
150 Opening ASCII mode data connection for /bin/ls.
-rw-------    1 root     root          899 Jun 10 08:11  bash_history
-rw-r--r--    1 root     root         4996 Jun 12 02:15 tcps2-release
226 Transfer complete
ftp>
```

3. From the W315/325/345, type:

```
# chmod +x tcps2-release
# ./tcps2-release &
```

```
192.168.3.127 – PuTTY
root@Moxa:~# ls –al
drwxr–xr-x  2 root  root     0 Jun 12 02:14
drwxr–xr-x 15 root  root     0 Jan  1   1970
-rw-------  1 root  root   899 Jun 10 08:11 .bash_history
-rw-r--r--  1 root  root  4996 Jun 12 02:15 tcps2-release
root@Moxa:~# chmod +x tcps2-release
root@Moxa:~# ls -al
drwxr–xr-x  2 root  root     0 Jun 12 02:14
drwxr–xr-x 15 root  root     0 Jan  1   1970
-rw-------  1 root  root   899 Jun 10 08:11 .bash_history
-rwxr-xr-x  1 root  root  4996 Jun 12 02:15 tcps2-release
root@Moxa:~#
```

4. The program should start running in the background. Use the **#ps –ef** command to check if the tcps2 program is actually running in the background.

**#ps // use this command to check if the program is running**

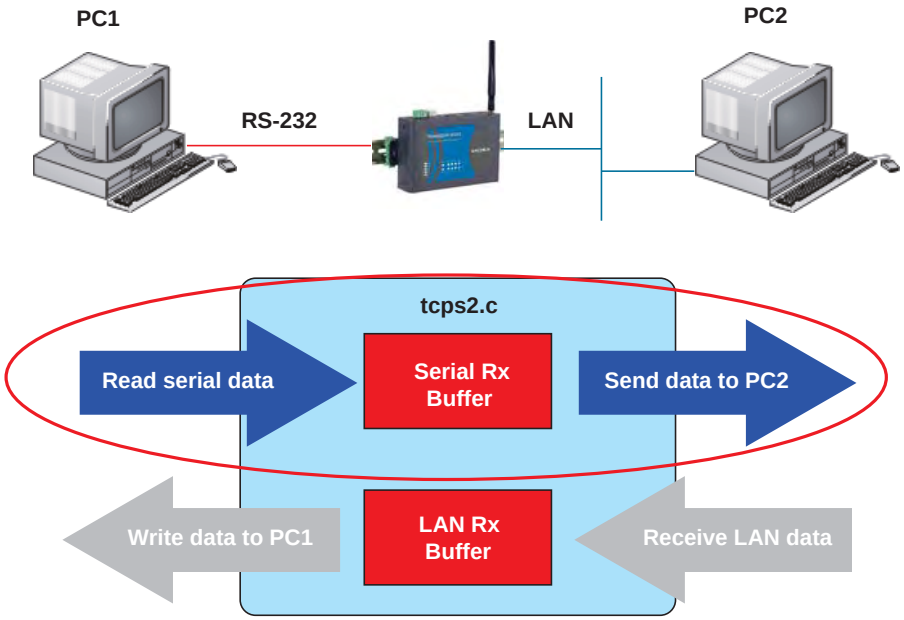
```
192.168.3.127 – PuTTY
[1]+  Running    ./tcps2-release &
root@Moxa:~# ps -ef
  PID  Uid    VmSize Stat Command
    1 root       532 S   init [3]
    2 root           SWN [ksoftirqd/0]
    3 root           SW< [events/0]
    4 root           SW< [khelper]
   13 root           SW< [kblockd/0]
   14 root           SW  [khubd]
   24 root           SW  [pdflush]
   25 root           SW  [pdflush]
   27 root           SW< [aio/0]
   26 root           SW  [kswapd0]
  604 root           SW  [mtdblockd]
  609 root           SW  [pccardd]
  611 root           SW  [pccardd]
  625 root           SWN [jffs2_gcd_mtd3]
  673 root       500 S   /bin/inetd
  679 root      3004 S   /usr/bin/httpd -k start -d /etc/apache
  682 bin        380 S   /bin/portmap
  685 root      1176 S   /bin/sh --login
  690 root       464 S   /bin/snmpd
  694 nobody    3012 S   /usr/bin/httpd -k start -d /etc/apache
  695 nobody    3012 S   /usr/bin/httpd -k start -d /etc/apache
  696 nobody    3012 S   /usr/bin/httpd -k start -d /etc/apache
  697 nobody    3012 S   /usr/bin/httpd -k start -d /etc/apache
  698 nobody    3012 S   /usr/bin/httpd -k start -d /etc/apache
  701 root       352 S   /bin/reportip
  714 root      1176 S   -bash
  726 root       436 S   /bin/telnetd
  727 root      1164 S   -bash
  728 root    1264 S ./tcps2-release
  729 root    1592 S ps -ef
root@Moxa:~#
```

NOTE Use the **kill -9** command for PID 728 to terminate this program: **#kill -9 728**

## Summary of the Testing Procedure

1. Compile **tcps2.c (#make**).
2. Upload and run **tcps2-release** in the background (**#./tcps2-release &**).
3. Check that the process is running (**#jobs** or **#ps -ef**).
4. Use a serial cable to connect PC1 to the W315/325/345's serial port 1.
5. Use an Ethernet cable to connect PC2 to the W315/325/345.
6. On PC1: If running Windows, use HyperTerminal (**38400, n, 8, 1**) to open COMn.
7. On PC2: Type **#telnet 192.168.3.127 4001**.
8. On PC1: Type some text on the keyboard and then press **Enter**.
9. On PC2: The text you typed on PC1 will appear on PC2's screen.

The testing environment is illustrated in the following figure. However, note that there are limitations to the example program **tcps2.c**.




NOTE The **tcps2.c** application is a simple example designed to give users a basic understanding of the concepts involved in combining Ethernet communication and serial port communication. However, the example program has some limitations that make it unsuitable for real-life applications.

1. The serial port is in canonical mode and block mode, making it impossible to send data from the Ethernet side to the serial side (i.e., from PC 2 to PC 1 in the above example).
2. The Ethernet side will not accept multiple connections.

# 3

# Managing Embedded Linux

This chapter includes information about version control, deployment, updates, and peripherals. The information in this chapter will be particularly useful when you need to run the same application on several W315/325/345 units.

The following topics are covered in this chapter:

- **System Version Information**
- **System Image Backup**
  - Upgrading the Firmware
  - Loading Factory Defaults
- **Enabling and Disabling Daemons**
- **Starting a Program Automatically at Run-Level**
- **Adjusting the System Time**
  - Setting the Time Manually
  - NTP Client
  - Updating the Time Automatically
- **Cron—Daemon to Execute Scheduled Commands**

# System Version Information

To determine the hardware capability of your W315/325/345, and what kind of software functions are supported, check the version numbers of your W315/325/345's hardware, kernel, and user file system. Contact Moxa to determine the hardware version. You will need the **Production S/N** (Serial number), which is located on the W315/325/345's bottom label.

To check the kernel version, type:
**#kversion**

```
192.168.3.127 - PuTTY
root@Moxa:~# kversion
W3x5 Version 1.0
root@Moxa:~#
```

NOTE The kernel version number is for the factory default configuration, and if you download the latest firmware version from Moxa's website and then upgrade the W315/325/345's hardware.

# System Image Backup

## Upgrading the Firmware

The W315/325/345's bios, kernel, and root file system are combined into one firmware file, which can be downloaded from Moxa's website (www.moxa.com). The name of the file has the form **w3x5-x.x.frm**, in which "x.x" indicates the firmware version (w3x5-x.x.x.frm for customized version). To upgrade the firmware, download the firmware file to a PC, and then transfer the file to the W315/325/345 through a console port or Telnet console connection.

ATTENTION

**Upgrading the firmware will erase all data on the Flash ROM**

If you are using the **ramdisk** to store code for your applications, beware that updating the firmware will erase all of the data on the Flash ROM. You should back up your application files and data before updating the firmware.

Since different Flash disks have different sizes, it's a good idea to check the size of your Flash disk before upgrading the firmware, or before using the disk to store your application and data files. Use the **#df -h** command to list the size of each memory block and how much free space is available in each block.

```
192.168.3.127 - PuTTY
 root@Moxa:~# df -h
 Filesystem   Size   Used Available Use% Mounted on
/dev/mtdblock2 8.0M     6.0M     2.0M   75% /
/dev/ram0      499.0k   16.0k    458.0k    3% /var
/dev/mtdblock3 6.0M    488.0k     5.5M    8% /tmp
/dev/mtdblock3 6.0M    488.0k     5.5M    8% /home
/dev/mtdblock3 6.0M    488.0k     5.5M    8% /etc
tmpfs          30.4M        0    30.4M    0% /dev/shm
 root@Moxa:~# upramdisk
 root@Moxa:~# df -h
 Filesystem   Size   Used Available Use% Mounted on
/dev/mtdblock2 8.0M     6.0M     2.0M   75% /
/dev/ram0      499.0k   16.0k    458.0k    3% /var
/dev/mtdblock3 6.0M    488.0k     5.5M    8% /tmp
/dev/mtdblock3 6.0M    488.0k     5.5M    8% /home
/dev/mtdblock3 6.0M    488.0k     5.5M    8% /etc
tmpfs          30.4M        0    30.4M    0% /dev/shm
/dev/ram1     16.0M    1.0k  15.1M    0%  /mnt/ramdisk
 root@Moxa:~# cd /mnt/ramdisk
 root@Moxa:/mnt/ramdisk#
```

The following instructions give the steps required to save the firmware file to the W315/325/345's RAM disk and how to upgrade the firmware.

1. Type the following commands to enable the RAM disk:

   ```
   #upramdisk
   #cd /mnt/ramdisk
   ```

2. Type the following commands to use the W315/325/345's built-in FTP client to transfer the firmware file (**w3x5-x.x.frm or w3x5-x.x.x.frm**) from the PC to the W315/325/345:

   ```
   /mnt/ramdisk> ftp <destination PC's IP>
   Login Name: xxxx
   Login Password: xxxx
   ftp> bin
   ftp> ftp> get w3x5-x.x.frm
   ```

```
192.168.3.127 – PuTTY
root@Moxa:/mnt/ramdisk# ftp 192.168.3.193
Connected to 192.168.3.193 (192.168.3.193).
220 TYPSoft FTP Server 1.10 ready…
Name (192.168.3.193:root): root
331 Password required for root.
Password:
230 User root logged in.
Remote system type is UNIX.
Using binary mode to transfer files.
ftp> cd newsw
250 CWD command successful. "/C:/ftproot/newsw/" is current directory.
ftp> bin
200 Type set to I.
ftp> ls
200 Port command successful.
150 Opening data connection for directory list.
drw-rw-rw-    1 ftp  ftp    0 Nov 30 10:03 .
drw-rw-rw-    1 ftp  ftp    0 Nov 30 10:03 .
-rw-rw-rw-    1 ftp  ftp 13167772 Nov 29 10:24 w3x5-1.0.frm
226 Transfer complete.
ftp> get w3x5-1.0.frm
local: w3x5-1.0.frm remote: w3x5-1.0.frm
200 Port command successful.
150 Opening data connection for w3x5-1.0.frm
226 Transfer complete.
13167772 bytes received in 2.17 secs (5925.8 kB/s)
ftp>
```

3. Next, use the **upfirm** command to upgrade the kernel and root file system:

**#upfirm w3x5-x.x.x.frm**

```
192.168.3.127 – PuTTY
root@Moxa:/mnt/ramdisk# upfirm w3x5-1.0.frm
Moxa  W3x5 upgrade firmware utility version 1.0.
To check source firmware file context.
The source firmware file conext is OK.
This step will destroy all your firmware.
Continue ? (Y/N) : Y
Now upgrade the file [kernel].
Format MTD device [/dev/mtd1] . . .
MTD device [/dev/mtd1] erase 128 Kibyte @ 1C0000 – 100% complete.
Wait to write file . . .
Compleleted 100%
Now upgrade the file [usrdisk].
Format MTD device [/dev/mtd2] . . .
MTD device [/dev/mtd2] erase 128 Kibyte @ 800000 – 100% complete.
Wait to write file . . .
Compleleted 100%
Upgrade the firmware is OK.
```

ATTENTION

The upfirm utility will reboot your target after the upgrade is OK.

## Loading Factory Defaults

To load the the factory default settings, you must press the reset-to-default button for more than 5 seconds. All files in the **/home** and **/etc** directories will be destroyed. Note that while pressing the reset-to-default button, the Ready LED will blink once every second for the first 5 seconds. The Ready LED will turn off after 5 seconds, and the factory defaults will be loaded.

# Enabling and Disabling Daemons

Daemons are programs which run in the background. Usually, they provide some kinds of services such as web access, FTP and email service etc. The following daemons are enabled when the W315/325/345 boots up.

**snmpd** .....SNMP Agent daemon
**telnetd** .....Telnet Server / Client daemon
**inetd** .....Internet Daemons
**ftpd**.....FTP Server / Client daemon
**sshd** .....Secure Shell Server daemon
**httpd** .....Apache WWW Server daemon

Type the command "ps" to list all processes currently running.

```
192.168.3.127 - PuTTY
root@Moxa:~# cd /etc
root@Moxa:/etc# ps
  PID  Uid     VmSize Stat Command
    1 root       532 S   init [3]
    2 root           SWN [ksoftirqd/0]
    3 root           SW< [events/0]
    4 root           SW< [khelper]
   13 root           SW< [kblockd/0]
   14 root           SW  [khubd]
   24 root           SW  [pdflush]
   25 root           SW  [pdflush]
   27 root           SW< [aio/0]
   26 root           SW  [kswapd0]
  604 root           SW  [mtdblockd]
  609 root           SW  [pccardd]
  611 root           SW  [pccardd]
  625 root           SWN [jffs2_gcd_mtd3]
  673 root       500 S   /bin/inetd
  679 root      3004 S   /usr/bin/httpd -k start -d /etc/apache
  682 bin        380 S   /bin/portmap
  685 root      1176 S   /bin/sh --login
  690 root       464 S   /bin/snmpd
  694 nobody    3012 S   /usr/bin/httpd -k start -d /etc/apache
  695 nobody    3012 S   /usr/bin/httpd -k start -d /etc/apache
  696 nobody    3012 S   /usr/bin/httpd -k start -d /etc/apache
  697 nobody    3012 S   /usr/bin/httpd -k start -d /etc/apache
  698 nobody    3012 S   /usr/bin/httpd -k start -d /etc/apache
  701 root       352 S   /bin/reportip
  714 root      1176 S   -bash
  726 root       436 S   /bin/telnetd
  727 root      1180 S   -bash
  783 root       628 R   ps -ef
root@Moxa:/ect#
```

To see all the daemons which run at bootup.

**#cd /etc/rc.d/rc3.d**

**#ls**

```
192.168.3.127 – PuTTY
root@Moxa:/ect/rc.d/rc3.d# ls
S19nfs-common  S25nfs-user-serverS99showreadyled
S20snmpd    S55ssh
S24pcmcia   S99rmnologin
root@Moxa:/etc/rc.d/rc3.d#
```

**#cd /etc/rc.d/init.d**

Edit a shell script to execute **/root/tcps2-release** and save to **tcps2** as an example.

**#cd /etc/rc.d/rc3.d**

**#ln –s /etc/rc.d/init.d/tcps2 S60tcps2**

SxxRUNFILE stands for

S: start the run file while linux boots up.

xx: a number between 00-99. Smaller numbers have a higher priority.

RUNFILE: the file name.

```
192.168.3.127 – PuTTY
root@Moxa:/ect/rc.d/rc3.d# ls
S19nfs-common  S25nfs-user-serverS99showreadyled
S20snmpd    S55ssh
S24pcmcia   S99rmnologin
root@Moxa:/ect/rc.d/rc3.d# ln –s /root/tcps2-release S60tcps2
root@Moxa:/ect/rc.d/rc3.d# ls
S19nfs-common  S25nfs-user-serverS99rmnologin
S20snmpd    S55ssh      S99showreadyled
S24pcmcia   S60tcps2
root@Moxa:/etc/rc.d/rc3.d#
```

KxxRUNFILE stands for

K: start the run file while linux shuts down or halts.

xx: a number between 00-99. Smaller numbers have a higher priority.

RUNFILE: the file name.

To remove the daemon, remove the run file from the **/etc/rc.d/rc3.d** directory by using the following command:

**#rm –f /etc/rc.d/rc3.d/S60tcps2**

# Starting a Program Automatically at Run-Level

To set a program running automatically at run-level, you can edit the file rc.local, as follows:

**#cd /etc/rc.d**

**#vi rc.local**

```
192.168.3.127 – PuTTY
root@Moxa:~# cd /etc/rc.d
root@Moxa:/etc/rc.d# vi rc.local
```

Next, use vi to open your application program. We use the example program **tcps2-release**, and put it to run in the background.

```
192.168.3.127 – PuTTY
# !/bin/sh
# Add you want to run daemon
/home/tcps2-release &~
```

The enabled daemons will be available after you reboot the system.

```
192.168.3.127 – PuTTY
root@Moxa:~# ps
  PID  Uid     VmSize Stat Command
    1 root       532 S   init [3]
    2 root           SWN [ksoftirqd/0]
    3 root           SW< [events/0]
    4 root           SW< [khelper]
   13 root           SW< [kblockd/0]
   14 root           SW  [khubd]
   24 root           SW  [pdflush]
   25 root           SW  [pdflush]
   27 root           SW< [aio/0]
   26 root           SW  [kswapd0]
  604 root           SW  [mtdblockd]
  609 root           SW  [pccardd]
  611 root           SW  [pccardd]
  625 root           SWN [jffs2_gcd_mtd3]
  673 root       500 S   /bin/inetd
  674 root      1264 S   /root/tcps2-release
  679 root      3004 S   /usr/bin/httpd -k start -d /etc/apache
  682 bin        380 S   /bin/portmap
  685 root      1176 S   /bin/sh --login
  690 root       464 S   /bin/snmpd
  694 nobody    3012 S   /usr/bin/httpd -k start -d /etc/apache
  695 nobody    3012 S   /usr/bin/httpd -k start -d /etc/apache
  696 nobody    3012 S   /usr/bin/httpd -k start -d /etc/apache
  697 nobody    3012 S   /usr/bin/httpd -k start -d /etc/apache
  698 nobody    3012 S   /usr/bin/httpd -k start -d /etc/apache
  701 root       352 S   /bin/reportip
  714 root      1176 S   -bash
  726 root       436 S   /bin/telnetd
  727 root      1180 S   -bash
  783 root       628 R   ps -ef
root@Moxa:~#
```

# Adjusting the System Time

## Setting the Time Manually

The W315/325/345 has two time settings. One is the system time, and the other is the RTC (Real Time Clock) time kept by the W315/325/345's hardware. Use the **#date** command to query the current system time or set a new system time. Use **#hwclock** to query the current RTC time or set a new RTC time.

Use the following command to query the system time:
**#date**

Use the following command to query the RTC time:
**#hwclock**

Use the following command to set the system time:
**#date MMDDhhmmYYYY**

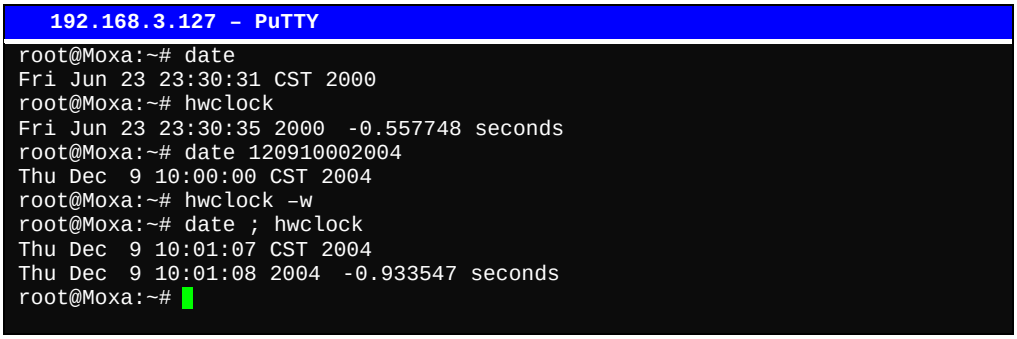
MM = Month
DD = Date
hhmm = hour and minute
YYYY = Year

Use the following command to set the RTC time:

**#hwclock –w**

Write current system time to RTC

The following figure illustrates how to update the system time and set the RTC time.

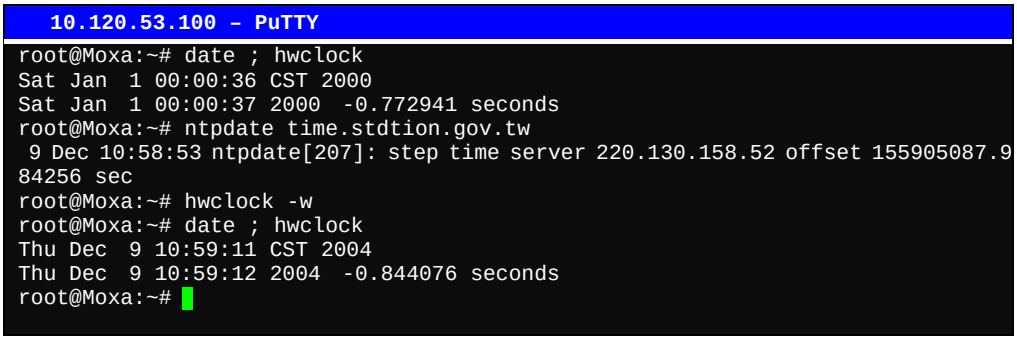

192.168.3.127 – PuTTY
root@Moxa:~# date
Fri Jun 23 23:30:31 CST 2000
root@Moxa:~# hwclock
Fri Jun 23 23:30:35 2000 -0.557748 seconds
root@Moxa:~# date 120910002004
Thu Dec 9 10:00:00 CST 2004
root@Moxa:~# hwclock –w
root@Moxa:~# date ; hwclock
Thu Dec 9 10:01:07 CST 2004
Thu Dec 9 10:01:08 2004 -0.933547 seconds
root@Moxa:~#

## NTP Client

The W315/325/345 has a built-in NTP (Network Time Protocol) client that is used to initialize a time request to a remote NTP server. Use **#ntpdate <this client utility>** to update the system time.

```
#ntpdate time.stdtime.gov.tw
#hwclock –w
```

Visit http://www.ntp.org for more information about NTP and NTP server addresses.


10.120.53.100 – PuTTY
root@Moxa:~# date ; hwclock
Sat Jan 1 00:00:36 CST 2000
Sat Jan 1 00:00:37 2000 -0.772941 seconds
root@Moxa:~# ntpdate time.stdtion.gov.tw
9 Dec 10:58:53 ntpdate[207]: step time server 220.130.158.52 offset 155905087.9
84256 sec
root@Moxa:~# hwclock -w
root@Moxa:~# date ; hwclock
Thu Dec 9 10:59:11 CST 2004
Thu Dec 9 10:59:12 2004 -0.844076 seconds
root@Moxa:~#

NOTE Before using the NTP client utility, check your IP and DNS settings to make sure that an Internet connection is available. Refer to Chapter 2 for instructions on how to configure the Ethernet interface, and see Chapter 4 for DNS setting information.

## Updating the Time Automatically

In this subsection, we show how to use a shell script to update the time automatically.

**Example shell script to update the system time periodically**

```
#!/bin/sh
ntpdate time.nist.gov # You can use the time server's ip address or domain
        # name directly. If you use domain name, you must
        # enable the domain client on the system by updating
        # /etc/resolv.conf file.
hwclock –-systohc
sleep 100  # Updates every 100 seconds. The sleeping time is 100 seconds. Change
    # 100 to a larger number to update RTC less often.
```

Save the shell script using any file name. E.g., **fixtime**

**How to run the shell script automatically when the kernel boots up**

Copy the example shell script **fixtime** to directory **/etc/init.d**, and then use **chmod 755 fixtime** to change the shell script mode. Next, use vi editor to edit the file **/etc/inittab**. Add the following line to the bottom of the file:

```
ntp : 2345 : respawn : /etc/init.d/fixtime
```

Use the command **#init q** to re-init the kernel.

# Cron—Daemon to Execute Scheduled Commands

Cron is a scheduling service in Linux. Cron wakes up every minute, and checks the configuration file named crontab to see if any scheduled command should be run in the current minute.

Crontab is located in the **/etc/cron.d** directory. Modify the file **/etc/cron.d/crontab** to set up your scheduled applications. Crontab has the following format:

| mm | h | dom | mon | dow | user | command |
|---|---|---|---|---|---|---|
| min | hour | date | month | week | user | command |
| 0-59 | 0-23 | 1-31 | 1-12 | 0-6 (0 is Sunday) | | |

The following example demonstrates how to use Cron.

**How to use cron to update the system time and RTC time every day at 8:00.**

**STEP1: Write a shell script named fixtime.sh and save it to /home/.**

```
#!/bin/sh
ntpdate time.nist.gov
hwclock –-systohc
exit 0
```

**STEP2: Change mode of fixtime.sh**

```
#chmod 755 fixtime.sh
```

**STEP3: Modify /etc/cron.d/crontab file to run fixtime.sh at 8:00 every day.**

Add the following line to the end of crontab:

```
* 8 * * * root /home/fixtime.sh
```

**STEP4: Enable the cron daemon manually.**

```
#/etc/init.d/cron start
```

**STEP5: Enable cron when the system boots up.**

By default, cron service is disabled on boot. To enable cron service, please refer to the section "Enabling and Disabling Daemons" in this chapter

# 4

# Managing Communications

In this chapter, we explain how to configure the W315/325/345's various communication functions.

The following topics are covered in this chapter:

- **Telnet / FTP**
- **DNS**
- **Web Service—Apache**
- **Install PHP for Apache Web Server**
- **IPTABLES**
  - Observe and erase chain rules
  - Define policy for chain rules
  - Append or delete rules:
- **NAT**
  - NAT Example
  - Enabling NAT at Bootup
- **Dial-up Service—PPP**
  - Example 1: Connecting to a PPP server over a simple dial-up connection
  - Example 2: Connecting to a PPP server over a hard-wired link
  - How to check the connection
  - Setting up a Machine for Incoming PPP Connections
- **PPPoE**
- **GPRS Connection**
- **NFS (Network File System)**
  - Setting up the W315/325/345 as an NFS Client
- **Mail**
- **SNMP**
- **OpenVPN**

# Telnet / FTP

In addition to supporting Telnet client/server and FTP client/server, the W315/325/345 also supports SSH and sftp client/server. To enable or disable the Telnet/ftp server, you first need to edit the file **/etc/inetd.conf**.

**Enabling the Telnet/ftp server**

The following example shows the default content of the file /etc/inetd.conf. The default is to enable the Telnet/ftp server:

```
discard dgram udp wait root /bin/discard
discard stream tcp nowait root /bin/discard
telnet stream tcp nowait root /bin/telnetd
ftp stream tcp nowait root /bin/ftpd -l
```

**Disabling the Telnet/ftp server**

Disable the daemon by typing '#' in front of the first character of the row to comment out the line.

# DNS

The W315/325/345 supports DNS client (but not DNS server). To set up DNS client, you need to edit three configuration files: **/etc/hosts**, **/etc/resolv.conf**, **and /etc/nsswitch.conf.**

**/etc/hosts**
This is the first file that the Linux system reads to resolve the host name and IP address.

**/etc/resolv.conf**
This is the most important file that you need to edit when using DNS for the other programs. For example, before you use **#ntpdate time.nist.goc** to update the system time, you will need to add the DNS server address to the file. Ask your network administrator which DNS server address you should use. The DNS server's IP address is specified with the "nameserver" command. For example, add the following line to /etc/resolv.conf if the DNS server's IP address is 168.95.1.1:

```
nameserver 168.95.1.1
```

**/etc/nsswitch.conf**
This file defines the sequence to resolve the IP address by using **/etc/hosts** or **/etc/resolv.conf**.

# Web Service—Apache

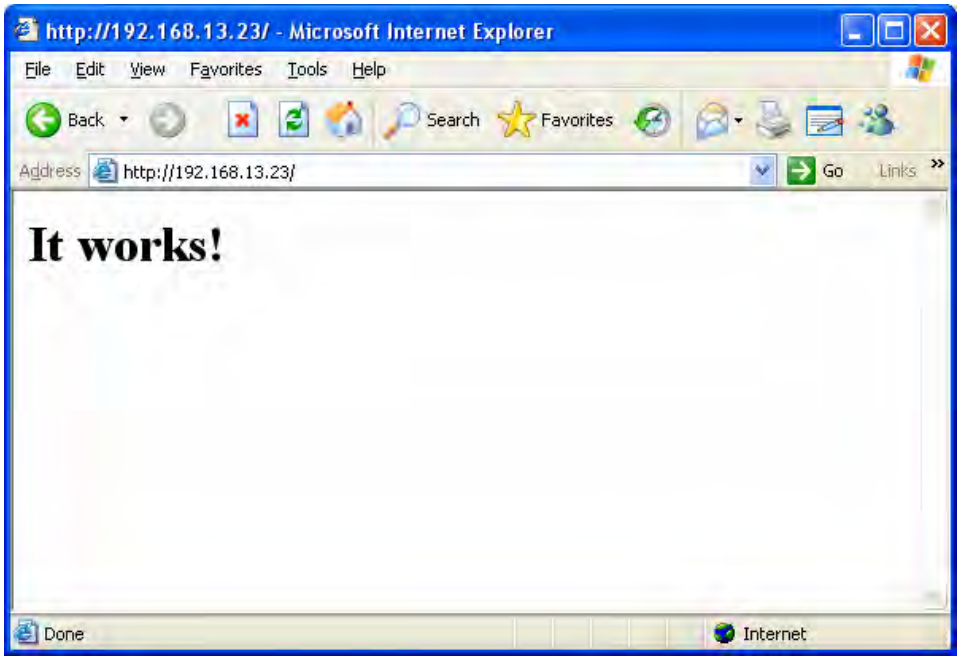
The Apache web server's main configuration file is **`/etc/apache/conf/httpd.conf`**, with the default homepage located at **`/home/httpd/htdocs/index.html`**. Save your own homepage to the following directory:

**/home/httpd/htdocs/**

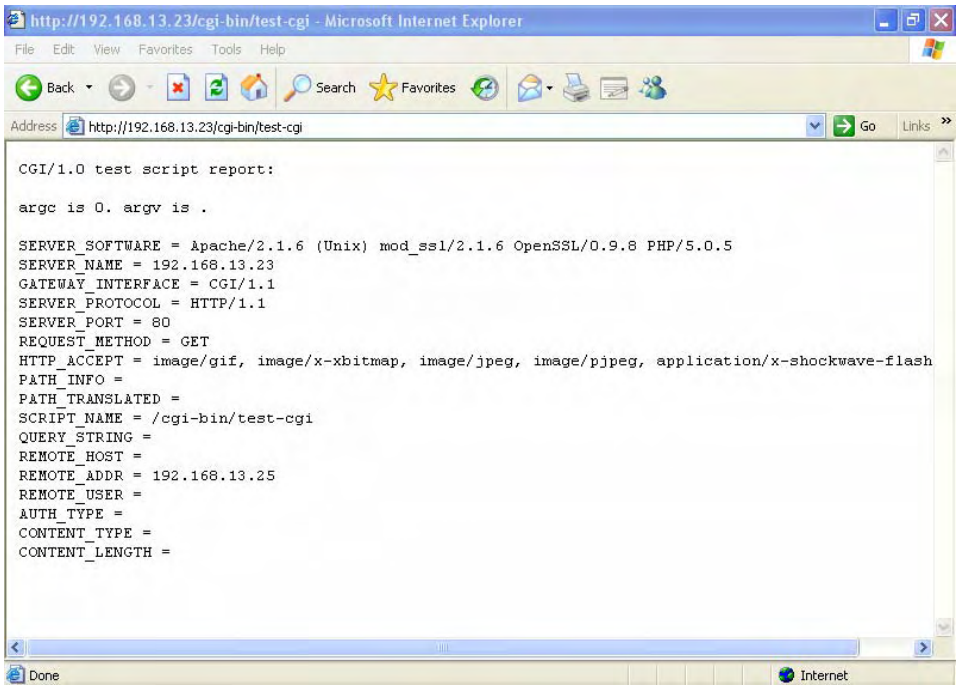
Save your CGI page to the following directory:

**/home/httpd/cgi-bin/**

Before you modify the homepage, use a browser (such as Microsoft Internet Explore or Mozilla Firefox) from your PC to test if the Apache Web Server is working. Type the LAN IP address in the browser's address box to open the homepage. E.g., if the default IP address is still active, type **http://192.168.3.127** in the address box.




To open the default CGI page, type **http://192.168.3.127/cgi-bin/test-cgi** in your browser's address box.




NOTE The CGI function is enabled by default. If you want to disable the function, modify the file **/etc/apache/conf/httpd.conf**. When you develop your own CGI application, make sure your CGI file is executable.

```
192.168.3.127 – PuTTY
root@Moxa:/home/httpd/cgi-bin# ls –al
drwxr–xr-x   2 root  root       0 Aug 24 1999
drwxr–xr-x   5 root  root       0 Nov  5 16:16
-rwxr–xr-x   1 root  root     757 Aug 24 1999 test-cgi
root@Moxa:/home/httpd/cgi-bin#
```

# Install PHP for Apache Web Server

This embedded computer supports the PHP option. However, since the PHP file is 3 MB, it is not installed by default. To install it yourself, first make sure there is enough free space (at least 3 MB) on your embedded flash ROM).

**Step 1:** Check that you have enough free space The following figure illustrates how to check that the **/dev/mtdblock3** has more than 3 MB of free space.

```
192.168.3.127 – PuTTY
root@Moxa:/bin# df -h
Filesystem              Size      Used Available Use% Mounted on
/dev/mtdblock2          8.0M      6.0M      2.0M  75% /
/dev/ram0             499.0k     17.0k    457.0k   4% /var
/dev/mtdblock3          6.0M    488.0k      5.5M   8% /tmp
/dev/mtdblock3          6.0M    488.0k      5.5M   8% /home
/dev/mtdblock3          6.0M    488.0k      5.5M   8% /etc
tmpfs                  30.4M         0     30.4M   0% /dev/shm
root@Moxa:/bin#
```

**Step 2:** Type **upramdisk** to get the free space ram disk to save the package.

```
192.168.3.127 – PuTTY
root@Moxa:/bin# upramdisk
root@Moxa:/bin# df -h
Filesystem              Size      Used Available Use% Mounted on
/dev/mtdblock2          8.0M      6.0M      2.0M  75% /
/dev/ram0             499.0k     18.0k    456.0k   4% /var
/dev/mtdblock3          6.0M    488.0k      5.5M   8% /tmp
/dev/mtdblock3          6.0M    488.0k      5.5M   8% /home
/dev/mtdblock3          6.0M    488.0k      5.5M   8% /etc
tmpfs                  30.4M         0     30.4M   0% /dev/shm
/dev/ram1              16.0M      1.0k     15.1M   0% /var/ramdisk
root@Moxa:/bin#
```

**Step 3:** Download the PHP package from the CD-ROM. You can find the package in **CD-ROM/software/php/php.tar.gz**.

```
192.168.3.127 – PuTTY
root@Moxa:/bin# cd /mnt/ramdisk
root@Moxa:/mnt/ramdisk# ftp 192.168.27.130
Connected to 192.168.27.130.
220 (vsFTPd 2.0.1)
Name (192.168.27.130:root): root
331 Please specify the password.
Password:
230 Login successful.
Remote system type is UNIX.
Using binary mode to transfer files.
ftp> cd /tmp
250 Directory successfully changed.
ftp> bin
200 Switching to Binary mode.
ftp> get php.tar.gz
local: php.tar.gz remote: php.tar.gz
200 PORT command successful. Consider using PASV.
150 Opening BINARY mode data connection for php.tar.gz (1789032 bytes).
226 File send OK.
1789032 bytes received in 0.66 secs (2.6e+03 Kbytes/sec)
ftp>
```

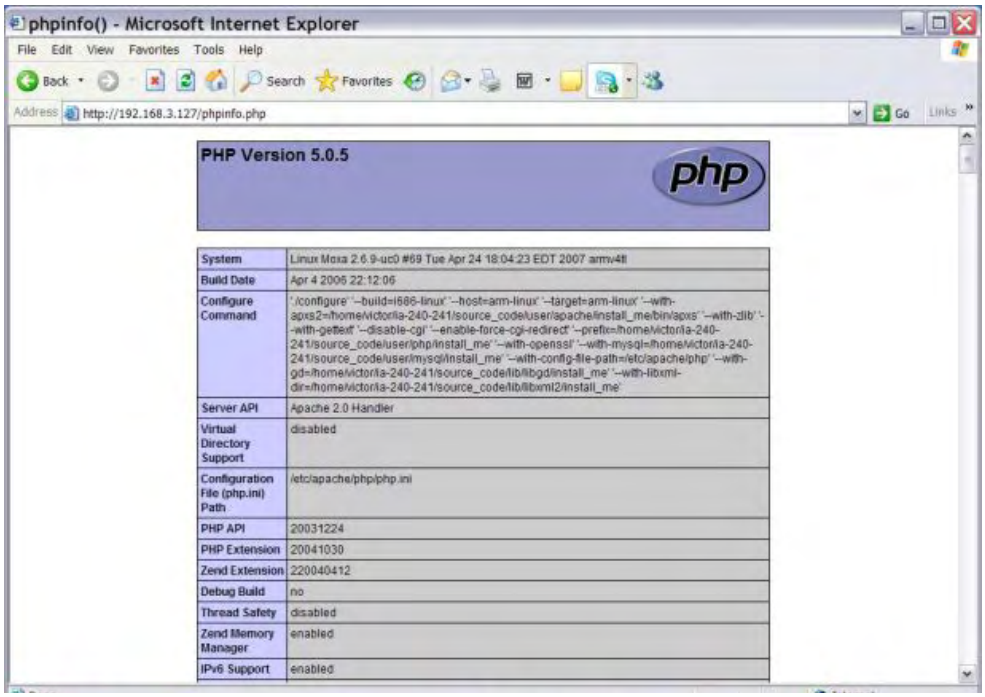
**Step 4:** Untar the package. To do this, type the command **tar xvzf php.tar.gz**.

```
192.168.3.127 – PuTTY
root@Moxa:/mnt/ramdisk# tar xvzf php.tar.gz
envvars
envvars.old
httpd.conf
httpd.conf.old
install.sh
lib
lib/libmysqlclient.so.15
lib/libpng.so.2
lib/libphp5.so
lib/libmysqlclient.so.15.0.0
lib/libgd.so
lib/libxml2.so.2.6.22
lib/libgd.so.2.0.0
lib/libjpeg.so
lib/libxml2.so.2
lib/libgd.so.2
php
php/php.ini
phpinfo.php
root@Moxa:/mnt/ramdisk#
```

**Step 5:** Run **install.sh** and select to install php.

```
192.168.3.127 – PuTTY
root@Moxa:/mnt/ramdisk# ./install.sh
Press the number:
1. Install PHP package
2. Uninstall PHP package
3. Exit.
1
Start to install PHP. Please wait ...
Starting web server: apache.
PHP install sucess.
root@Moxa:/mnt/ramdisk#
```

**Step 6:** Test it. Use the browser to access http://192.168.3.127/phpinfo.php.




If you want to uninstall PHP, follow steps 2 to 5 but select the uninstall option.

# IPTABLES

IPTABLES is an administrative tool for setting up, maintaining, and inspecting the Linux kernel's IP packet filter rule tables. Several different tables are defined, with each table containing built-in chains and user-defined chains.

Each chain is a list of rules that apply to a certain type of packet. Each rule specifies what to do with a matching packet. A rule (such as a jump to a user-defined chain in the same table) is called a "target."

The W315/325/345 supports 3 types of IPTABLES table: **Filter** tables, **NAT** tables, and **Mangle** tables:

A. **Filter Table**—includes three chains:

INPUT chain
OUTPUT chain
FORWARD chain

B. **NAT Table**—includes three chains:

PREROUTING chain—transfers the destination IP address (DNAT)

POSTROUTING chain—works after the routing process and before the Ethernet device process to transfer the source IP address (SNAT)

OUTPUT chain—produces local packets

*sub-tables*

Source NAT (SNAT)—changes the first source packet IP address

Destination NAT (DNAT)—changes the first destination packet IP address

MASQUERADE—a special form for SNAT. If one host can connect to Internet, then other computers that connect to this host can connect to the Internet when the computer does not have an actual IP address.

REDIRECT—a special form of DNAT that re-sends packets to a local host independent of the destination IP address.

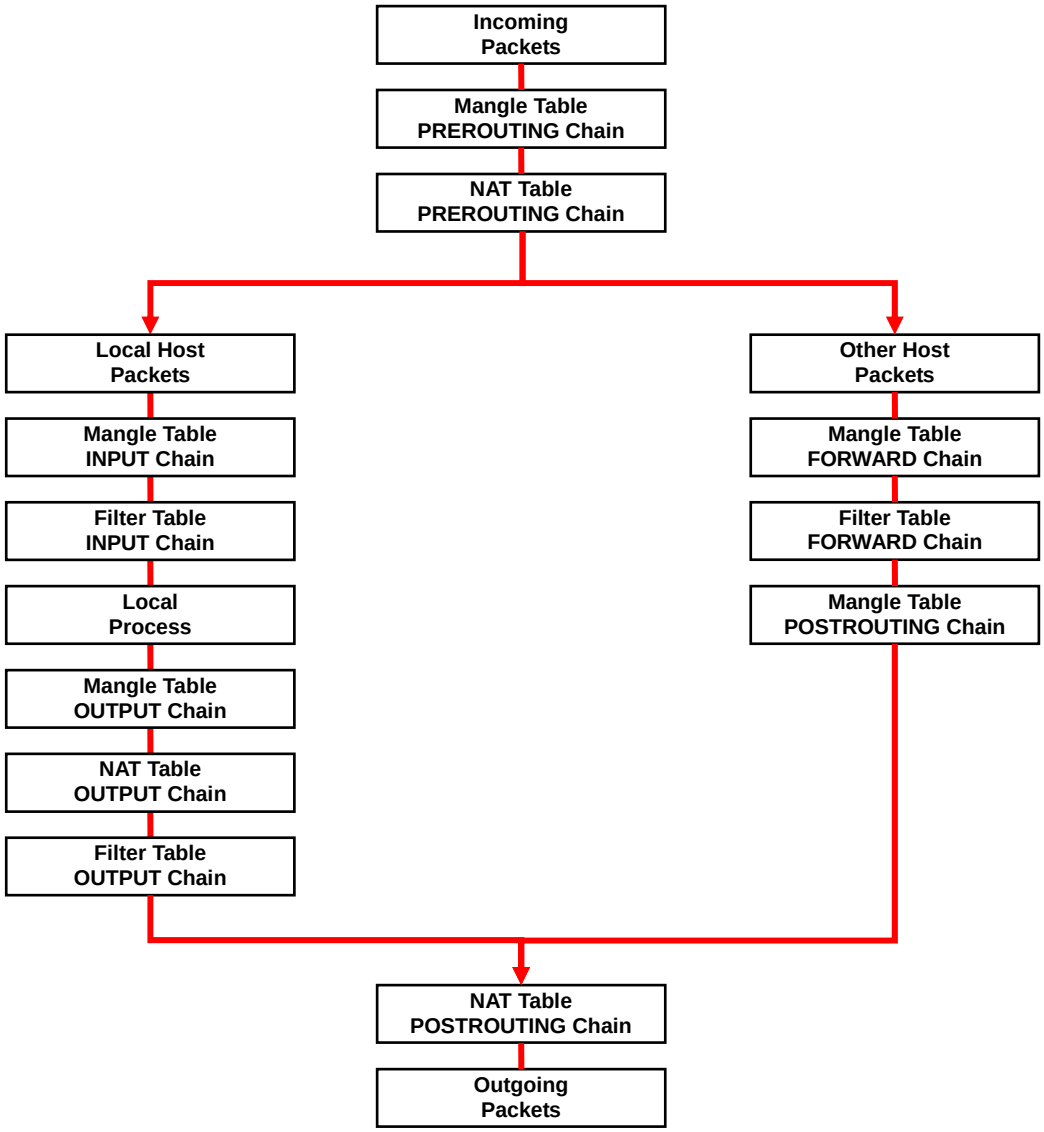
C. **Mangle Table**—includes two chains

PREROUTING chain—pre-processes packets before the routing process.

OUTPUT chain—processes packets after the routing process.

It has three extensions—TTL, MARK, TOS.

The following figure shows the IPTABLES hierarchy.



The W315/325/345 supports the following sub-modules. Be sure to use the module that matches your application.

| | | | |
|---|---|---|---|
| ip_conntrack | ipt_MARK | ipt_ah | ipt_state |
| ip_conntrack_ftp | ipt_MASQUERADE | ipt_esp | ipt_tcpmss |
| ipt_conntrack_irc | ipt_MIRROT | ipt_length | ipt_tos |
| ip_nat_ftp | ipt_REDIRECT | ipt_limit | ipt_ttl |
| ip_nat_irc | ipt_REJECT | ipt_mac | ipt_unclean |
| ip_nat_snmp_basic | ipt_TCPMSS | ipt_mark | |
| ip_queue | ipt_TOS | ipt_multiport | |
| ipt_LOG | ipt_ULOG | ipt_owner | |

NOTE The W315/325/345 does NOT support IPV6 and ipchains.

The basic syntax to enable and load an IPTABLES module is as follows:

```
#lsmod
#insmod ip_tables
#insmod iptable_filter
```

Use **lsmod** to check if the ip_tables module has already been loaded in the W315/325/345. Use **insmod** to insert and enable the module.

Use the following command to load the modules (iptable_filter, iptable_mangle, iptable_nat):

```
#insmod iptable_filter
```

NOTE IPTABLES plays the role of packet filtering or NAT. Take care when setting up the IPTABLES rules. If the rules are not correct, remote hosts that connect via a LAN or PPP may be denied access. We recommend using the Serial Console to set up the IPTABLES.

Click on the following links for more information about iptables.

http://www.linuxguruz.com/iptables/
http://www.netfilter.org/documentation/HOWTO//packet-filtering-HOWTO.html

Since the IPTABLES command is very complex, to illustrate the IPTABLES syntax we have divided our discussion of the various rules into three categories: **Observe and erase chain rules**, **Define policy rules,** and **Append or delete rules**.

## Observe and erase chain rules

**Usage:**

```
# iptables [-t tables] [-L] [-n]
```

-t tables: Table to manipulate (default: 'filter'); example: nat or filter.
-L [chain]: ListList all rules in selected chains. If no chain is selected, all chains are listed.
-n: Numeric output of addresses and ports.

```
# iptables [-t tables] [-FXZ]
```

-F: Flush the selected chain (all the chains in the table if none is listed).
-X: Delete the specified user-defined chain.
-Z: Set the packet and byte counters in all chains to zero.

**Examples:**

```
# iptables -L -n
```

In this example, since we do not use the -t parameter, the system uses the default 'filter' table. Three chains are included: INPUT, OUTPUT, and FORWARD. INPUT chains are accepted automatically, and all connections are accepted without being filtered.

```
#iptables –F
#iptables –X
#iptables -Z
```

## Define policy for chain rules

**Usage:**

```
# iptables [-t tables] [-P] [INPUT, OUTPUT, FORWARD, PREROUTING, OUTPUT, POSTROUTING]
[ACCEPT, DROP]
```

-P: Set the policy for the chain to the given target.
INPUT: For packets coming into the W315/325/345.
OUTPUT: For locally-generated packets.
FORWARD: For packets routed out through the W315/325/345.
PREROUTING: To alter packets as soon as they come in.
POSTROUTING: To alter packets as they are about to be sent out.

**Examples:**

```
#iptables –P INPUT DROP
#iptables –P OUTPUT ACCEPT
#iptables –P FORWARD ACCEPT
#iptables –t nat –P PREROUTING ACCEPT
#iptables –t nat –P OUTPUT ACCEPT
#iptables -t nat –P POSTROUTING ACCEPT
```

In the above example, the policy accepts outgoing packets and denies incoming packets.

## Append or delete rules:

**Usage:**

```
# iptables [-t table] [-AI] [INPUT, OUTPUT, FORWARD] [-io interface] [-p tcp, udp, icmp,
all] [-s IP/network] [--sport ports] [-d IP/network] [--dport ports] –j [ACCEPT. DROP]
```

-A: Append one or more rules to the end of the selected chain.
-I: Insert one or more rules in the selected chain as the given rule number.
-i: Name of an interface via which a packet is going to be received.
-o: Name of an interface via which a packet is going to be sent.
-p: The protocol of the rule or of the packet to check.
-s: Source address (network name, host name, network IP address, or plain IP address).
--sport: Source port number.
-d: Destination address.
--dport: Destination port number.
-j: Jump target. Specifies the target of the rules; i.e., how to handle matched packets. For example, ACCEPT the packet, DROP the packet, or LOG the packet.

**Examples:**

Example 1: Accept all packets from lo interface.

```
# iptables –A INPUT –i lo –j ACCEPT
```

Example 2: Accept TCP packets from 192.168.0.1.

```
# iptables –A INPUT –i eth0 –p tcp –s 192.168.0.1 –j ACCEPT
```

Example 3: Accept TCP packets from Class C network 192.168.1.0/24.

```
# iptables –A INPUT –i eth0 –p tcp –s 192.168.1.0/24 –j ACCEPT
```

Example 4: Drop TCP packets from 192.168.1.25.

```
# iptables –A INPUT –i eth0 –p tcp –s 192.168.1.25 –j DROP
```

Example 5: Drop TCP packets addressed for port 21.

```
# iptables –A INPUT –i eth0 –p tcp --dport 21 –j DROP
```

Example 6: Accept TCP packets from 192.168.0.24 to W315/325/345's port 137, 138, 139

```
# iptables –A INPUT –i eth0 –p tcp –s 192.168.0.24 --dport 137:139 –j ACCEPT
```

Example 7: Drop all packets from MAC address 01:02:03:04:05:06.

```
# iptables –A INPUT –i eth0 –p all –m mac –-mac-source 01:02:03:04:05:06 –j DROP
```

NOTE: In Example 7, remember to issue the command **`#insmod ipt_mac`** first to load module **ipt_mac**.

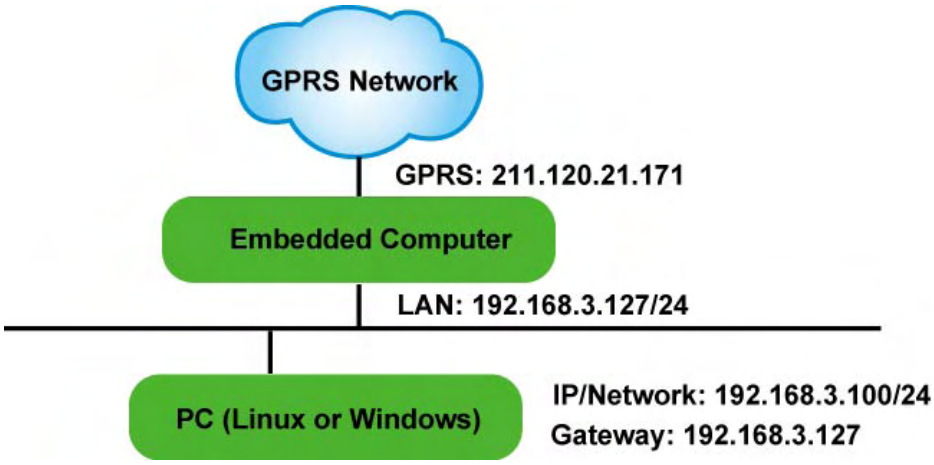
# NAT

NAT (Network Address Translation) protocol translates IP addresses used on one network to different IP addresses used on another network. One network is designated the inside network and the other is the outside network. Typically, the W315/325/345 connects several devices on a network and maps local inside network addresses to one or more global outside IP addresses, and un-maps the global IP addresses on incoming packets back into local IP addresses.

NOTE Click on the following link for more information about iptables and NAT: http://www.netfilter.org/documentation/HOWTO/NAT-HOWTO.html

## NAT Example

The IP address of the LAN is changed to 192.168.3.127 (you will need to load the module ipt_MASQUERADE):




```
1. #echo 1 > /proc/sys/net/ipv4/ip_forward
2. #insmod ip_tables
3. #insmod iptable_filter
4. #insmod  ip_conntrack
5. #insmod  iptable_nat
6. #insmod  ipt_MASQUERADE
7. #iptables -t nat -A POSTROUTING -o eth0 -j SNAT --to-source 192.168.3.127
8. #iptables –t nat –A POSTROUTING –o eth0 –s 192.168.3.0/24 –j MASQUERADE
```

## Enabling NAT at Bootup

In most real world situations, you will want to use a simple shell script to enable NAT when the W315/325/345 boots up. The following script is an example.

```
#!/bin/bash
# If you put this shell script in the /home/nat.sh
# Remember to chmod 744 /home/nat.sh
# Edit the rc.local file to make this shell startup automatically.
# vi /etc/rc.d/rc.local
# Add a line in the end of rc.local /home/nat.sh
EXIF='eth0'  #This is an external interface for setting up a valid IP address.
EXNET='192.168.4.0/24'  #This is an internal network address.
# Step 1. Insert modules.
# Here 2> /dev/null means the standard error messages will be dump to null device.
insmod ip_tables  2> /dev/null
insmod ip_conntrack  2> /dev/null
insmod ip_conntrack_ftp  2> /dev/null
insmod ip_conntrack_irc  2> /dev/null
insmod iptable_nat 2> /dev/null
insmod ip_nat_ftp 2> /dev/null
insmod ip_nat_irc 2> /dev/null

# Step 2. Define variables, enable routing and erase default rules.

PATH=/bin:/sbin:/usr/bin:/usr/sbin:/usr/local/bin:/usr/local/sbin
export PATH
echo "1" > /proc/sys/net/ipv4/ip_forward
/bin/iptables -F
/bin/iptables -X
/bin/iptables -Z
```

```
/bin/iptables -F -t nat
/bin/iptables -X -t nat
/bin/iptables -Z -t nat
/bin/iptables -P INPUT  ACCEPT
/bin/iptables -P OUTPUT  ACCEPT
/bin/iptables -P FORWARD ACCEPT
/bin/iptables -t nat -P PREROUTING  ACCEPT
/bin/iptables -t nat -P POSTROUTING ACCEPT
/bin/iptables -t nat -P OUTPUT     ACCEPT

# Step 3. Enable IP masquerade.
```

# Dial-up Service—PPP

PPP (Point to Point Protocol) is used to run IP (Internet Protocol) and other network protocols over a serial link. PPP can be used for direct serial connections (using a null-modem cable) over a Telnet link, and links established using a modem over a telephone line.

Modem / PPP access is almost identical to connecting directly to a network through the W315/325/345's Ethernet port. Since PPP is a peer-to-peer system, the W315/325/345 can also use PPP to link two networks (or a local network to the Internet) to create a Wide Area Network (WAN).

NOTE Click on the following links for more information about ppp:
http://tldp.org/HOWTO/PPP-HOWTO/index.html
http://axion.physics.ubc.ca/ppp-linux.html

The pppd daemon is used to connect to a PPP server from a Linux system. For detailed information about pppd see the man page.

## Example 1: Connecting to a PPP server over a simple dial-up connection

The following command is used to connect to a PPP server by modem. Use this command for old ppp servers that prompt for a login name (replace username with the correct name) and password (replace password with the correct password). Note that debug and defaultroute 192.1.1.17 are optional.

```
#pppd connect 'chat -v " " ATDT5551212 CONNECT" " ogin: username word: password'
/dev/ttyM0 115200 debug crtscts modem defaultroute
```

If the PPP server does not prompt for the username and password, the command should be entered as follows. Replace *username* with the correct username and replace *password* with the correct password.

```
#pppd connect 'chat -v " " ATDT5551212 CONNECT" " ' user username password password
/dev/ttyM0 115200 crtscts modem
```

The pppd options are described below:

**connect 'chat etc...'**
This option gives the command to contact the PPP server. The 'chat' program is used to dial a remote computer. The entire command is enclosed in single quotes because pppd expects a one-word argument for the 'connect' option. The options for 'chat' are given below:

**-v**
verbose mode; log what we do to syslog

**" "**

Double quotes—don't wait for a prompt, but instead do ... (note that you must include a space after the second quotation mark)

**ATDT5551212**

Dial the modem, and then ...

**CONNECT**
Wait for an answer.

**" "**

Send a return (null text followed by the usual return)

**ogin: *username* word: *password***
Log in with *username* and *password*.

Refer to the chat man page, chat.8, for more information about the chat utility.

**/dev/**
Specify the callout serial port.

**115200**
The baudrate.

**debug**
Log status in syslog.

**crtscts**
Use hardware flow control between computer and modem (at 115200 this is a must).

**modem**
Indicates that this is a modem device; pppd will hang up the phone before and after making the call.

**defaultroute**
Once the PPP link is established, make it the default route; if you have a PPP link to the Internet, this is probably what you want.

**192.1.1.17**
This is a degenerate case of a general option of the form x.x.x.x:y.y.y.y. Here x.x.x.x is the local IP address and y.y.y.y is the IP address of the remote end of the PPP connection. If this option is not specified, or if just one side is specified, then x.x.x.x defaults to the IP address associated with the local machine's hostname (located in **/etc/hosts**), and y.y.y.y is determined by the remote machine.

## Example 2: Connecting to a PPP server over a hard-wired link

If a username and password are not required, use the following command (note that *noipdefault* is optional):

```
#pppd connect 'chat –v" " " " ' noipdefault /dev/ttyM0 19200 crtscts
```

If a username and password is required, use the following command (note that *noipdefault* is optional, and *root* is both the username and password):

```
#pppd connect 'chat –v" " " " ' user root password root noipdefault
/dev/ttyM0 19200 crtscts
```

## How to check the connection

Once you've set up a PPP connection, there are some steps you can take to test the connection. First, type:

```
#ifconfig
```

You should be able to see all the network interfaces that are UP. ppp0 should be one of them, and you should recognize the first IP address as your own, and the "P-t-P address" (or point-to-point address) the address of your server. Here's what it looks like on one machine:

| | |
|---|---|
| lo | Link encap Local Loopback |
| | inet addr 127.0.0.1 Bcast 127.255.255.255 Mask 255.0.0.0 |
| | UP LOOPBACK RUNNING MTU 2000 Metric 1 |
| | RX packets 0 errors 0 dropped 0 overrun 0 |
| | |
| ppp0 | Link encap Point-to-Point Protocol |
| | inet addr 192.76.32.3 P-t-P 129.67.1.165 Mask 255.255.255.0 |
| | UP POINTOPOINT RUNNING MTU 1500 Metric 1 |
| | RX packets 33 errors 0 dropped 0 overrun 0 |
| | TX packets 42 errors 0 dropped 0 overrun 0 |

Now, type:

```
ping z.z.z.z
```

where z.z.z.z is the address of your name server. This should work. Here's what the response could look like:

| |
|---|
| **# ping 129.67.1.165** |
| PING 129.67.1.165 (129.67.1.165): 56 data bytes |
| 64 bytes from 129.67.1.165: icmp_seq=0 ttl=225 time=268 ms |
| 64 bytes from 129.67.1.165: icmp_seq=1 ttl=225 time=247 ms |
| 64 bytes from 129.67.1.165: icmp_seq=2 ttl=225 time=266 ms |
| ^C |
| --- 129.67.1.165 ping statistics --- |
| 3 packets transmitted, 3 packets received, 0% packet loss |
| round-trip min/avg/max = 247/260/268 ms |
| waddington:~$ |

Try typing:

```
netstat -nr
```

This should show three routes, something like this:

| Kernel routing table | | | | | | |
|---|---|---|---|---|---|---|
| Destination | Gateway | Genmask | Flags | Metric | Ref | Use |
| iface | | | | | | |
| 129.67.1.165 | 0.0.0.0 | 255.255.255.255 | UH | 0 | 0 | 6 |
| ppp0 | | | | | | |
| 127.0.0.0 | 0.0.0.0 | 255.0.0.0 | U | 0 | 0 | 0 lo |
| 0.0.0.0 | 129.67.1.165 | 0.0.0.0 | UG | 0 | 0 | 6298 |
| ppp0 | | | | | | |

If your output looks similar but doesn't have the destination 0.0.0.0 line (which refers to the default route used for connections), you may have run pppd without the 'defaultroute' option. At this point you can try using Telnet, ftp, or finger, bearing in mind that you'll have to use numeric IP addresses unless you've set up /etc/resolv.conf correctly.

## Setting up a Machine for Incoming PPP Connections

This first example applies to using a modem, and requiring authorization with a username and password.

```
pppd/dev/ttyM0 115200 crtscts modem 192.168.16.1:192.168.16.2 login auth
```

You should also add the following line to the file **/etc/ppp/pap-secrets**:

```
*    *    “”    *
```

The first star (*) lets everyone login. The second star (*) lets every host connect. The pair of double quotation marks (“”) is to use the file **/etc/passwd** to check the password. The last star (*) is to let any IP connect.

The following example does not check the username and password:

```
pppd/dev/ttyM0 115200 crtscts modem 192.168.16.1:192.168.16.2
```

# PPPoE

1. Connect the W315/325/345's LAN port to an ADSL modem with a cross-over cable, HUB, or switch.
2. Log on to the W315/325/345 as the root user.
3. Edit the file **/etc/ppp/chap-secrets** and add the following text:

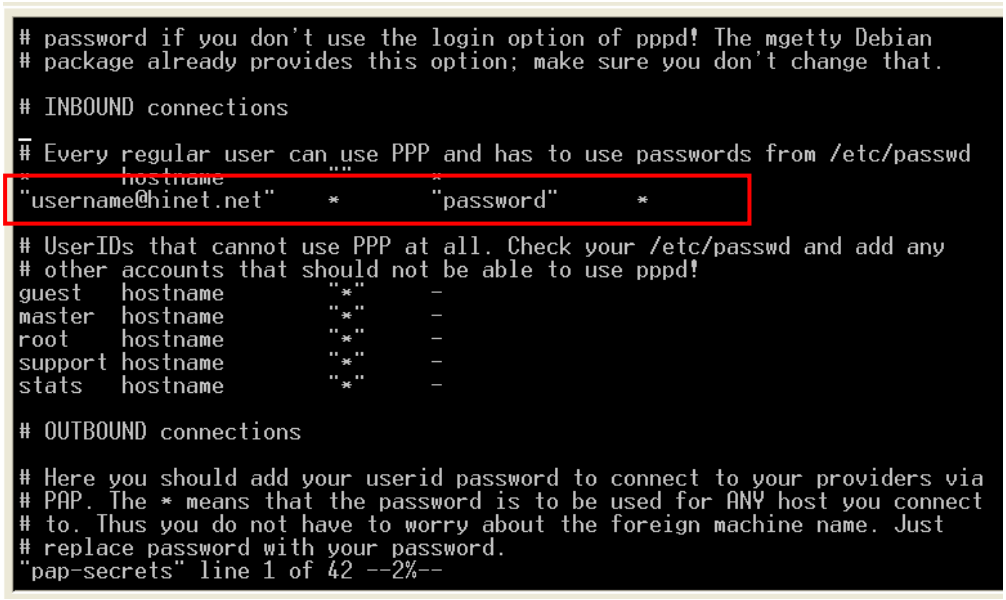
   **“username@hinet.net”*“password”***

# Secrets for authentication using CHAP
# client server secret IP addresses
"username@hinet.net" * "password" *
"chap-secrets" line 1 of 3 --33%--

**“username@hinet.net”** is the username obtained from the ISP to log in to the ISP account.
**“password”** is the corresponding password for the account.

4. Edit the file **/etc/ppp/pap-secrets** and add the following text:

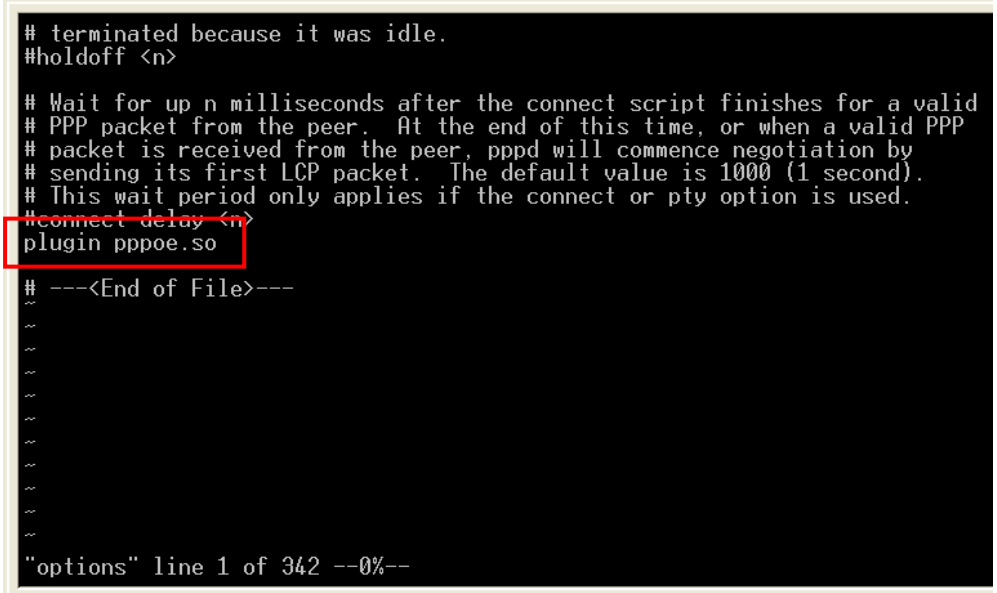
   **"username@hinet.net"*"password"***


# password if you don't use the login option of pppd! The mgetty Debian
# package already provides this option; make sure you don't change that.
# INBOUND connections
# Every regular user can use PPP and has to use passwords from /etc/passwd
"username@hinet.net" * "password" *
# UserIDs that cannot use PPP at all. Check your /etc/passwd and add any
# other accounts that should not be able to use pppd!
guest hostname "*" -
master hostname "*" -
root hostname "*" -
support hostname "*" -
stats hostname "*" -
# OUTBOUND connections
# Here you should add your userid password to connect to your providers via
# PAP. The * means that the password is to be used for ANY host you connect
# to. Thus you do not have to worry about the foreign machine name. Just
# replace password with your password.
"pap-secrets" line 1 of 42 --2%--

   **"username@hinet.net"** is the username obtained from the ISP to log in to the ISP account.
   **"password"** is the corresponding password for the account.

5. Edit the file **/etc/ppp/options** and add the following line:

   **plugin pppoe**


# terminated because it was idle.
#holdoff <n>
# Wait for up n milliseconds after the connect script finishes for a valid
# PPP packet from the peer. At the end of this time, or when a valid PPP
# packet is received from the peer, pppd will commence negotiation by
# sending its first LCP packet. The default value is 1000 (1 second).
# This wait period only applies if the connect or pty option is used.
#connect-delay <n>
plugin pppoe.so
# ---<End of File>---
"options" line 1 of 342 --0%--

6. Edit the file **/etc/ppp/options.eth0**.

Type your username (the one you set in the **/etc/ppp/pap-secrets** and **/etc/ppp/chap-secrets** files) after the "name" option. You may add other options as desired.

7. Set up DNS

   If you are using DNS servers supplied by your ISP, edit the file **/etc/resolv.conf** by adding the following lines of code:

   **nameserver ip_addr_of_first_dns_server**

   **nameserver ip_addr_of_second_dns_server**

   For example:

   **nameserver 168..95.1.1**

   **nameserver 139.175.10.20**

8. Use the following command to create a pppoe connection:

   **pppd eth0**

   The eth0 is what is connected to the ADSL modem LAN port.

9. Type **ifconfig ppp0** to check if the connection is OK or has failed. If the connection is OK, you will see information about the ppp0 setting for the IP address. Use ping to test the IP.

10. If you want to disconnect it, use the kill command to kill the pppd process.

# GPRS Connection

GPRS is a packet-switched technology, which means that multiple users share the same transmission channel. In addition, GPRS transmits only when there is outgoing data. The available bandwidth can be dedicated solely to data communication when needed. In general, a GPRS network can be viewed as a special IP network that offers IP connectivity to IP terminals.

The concepts of making GPRS connection are the same as the dial up service using PPP (please refer to the section "**Dial-up Service-PPP**" in chapter 4 for details). As the pppd daemon starts, it prepares the serial port settings for communication. Then it runs an external program called **chat**, which sends AT commands to GSM/GPRS module to establish connection. AT commands are just like the language between chat program and GSM/GPRS module. The **chat** program waits for the string CONNECT to establish connection. After the connection is established, pppd takes over the process to encapsulate TCP/IP packets.

The W315/325/345 embedded computers provide a ready-to-use sccript **gprscmd** for fast connections (please refer to "**Connecting to GPRS network**" in chapter 2). We recommend that users use the **gprscmd** command instead of rewriting their own connection command. Users who need to customize their own connection for specific needs can edit the following files to meet their own connection standard.

## Configuring the options for pppd

The option settings for pppd is located at **/etc/ppp/peers/chtgprs**. You can enable or disable an option by removing or deleting the "**#**"

```
# File: /etc/ppp/peers/chtgprs
#
/dev/ttyS1          # modem port used
115200              # speed
defaultroute        # use the cellular network for the default route
noipdefault
usepeerdns          # use the DNS servers from the remote network
#nodetach           # keep pppd in the foreground
#nocrtscts          # hardware flow control
#lock               # lock the serial port
noauth              # don't expect the modem to authenticate itself
#local              # don't use Carrier Detect or Data Terminal Ready
#persist
#demand
modem
#debug
# Use the next two lines if you receive the dreaded messages:
#
#       No response to n echo-requests
#       Serial link appears to be disconnected.
#       Connection terminated.
#
lcp-echo-failure 4
lcp-echo-interval 65535
connect       "/bin/chat -v -f /etc/chatscripts/chtgprs-connect"
```

## Configuring the AT commands

The AT command set for connecting a GPRS module is located at **/etc/chatscripts/chtgprs-connect**. You can add your own AT commands in the following the format.

```
# File: /etc/chatscripts/chtgprs-connect
#
TIMEOUT 10
ABORT    'BUSY'
ABORT    'NO ANSWER'
ABORT    'ERROR'
SAY      'Starting GPRS connect script\n'
# Get the modem's attention and reset it.
""       'ATZ'

# E0=No echo, V1=English result codes
OK       'ATE0V1'

# Set Access Point Name (APN)
SAY      'Setting APN\n'
OK       'AT+CGDCONT=1,"IP","internet"'

# Dial the number
ABORT    'NO CARRIER'
SAY      'Dialing...\n'
OK       'ATD*99***1#'
CONNECT ''
```

## Example: Selecting the radio band

The GSM/GPRS module is configured to 900/1800 MHz by default. Althought GSM-900 and GSM-1800 are used in most parts of the world, operators in the United States, Canada, and many other countries in the Americas use GSM-850 or GSM-1900. For users in these areas, the radio band can be reconfigured by adding an AT command in **/etc/chatscripts/chtgprs-connect**.

```
OK       ' AT+WMBS=x'
```

The 'x' represents one of the band selections shown in the following table.

| x | Radio Band Selection |
|---|---|
| 0 | Mono-band, 850 MHz |
| 1 | Mono-band, 900 MHz |
| 2 | Mono-band, 1800 MHz |
| 3 | Mono-band, 1900 MHz |
| 4 | Dual-band, 850/1900 MHz |
| 5 | Dual-band, 900/1800 MHz |
| 6 | Dual-band, 900/1900 MHz |

NOTE After setting customized connection, we recommend running the command **gprscmd** to initiate a GPRS connection.

# NFS (Network File System)

The Network File System (NFS) is used to mount a disk partition on a remote machine, as if it were on a local hard drive, allowing fast, seamless sharing of files across a network. NFS allows users to develop applications for the W315/325/345, without worrying about the amount of disk space that will be available. The W315/325/345 supports NFS protocol for client.

NOTE Click on the following links for more information about NFS:
http://www.tldp.org/HOWTO/NFS-HOWTO/index.html
http://nfs.sourceforge.net/nfs-howto/client.html
http://nfs.sourceforge.net/nfs-howto/server.html

## Setting up the W315/325/345 as an NFS Client

The following procedure is used to mount a remote NFS Server.

1. To know the NFS Server's shared directory.
2. Establish a mount point on the NFS Client site.
3. Mount the remote directory to a local directory.

```
#mkdir –p /home/nfs/public
#mount –t nfs NFS_Server(IP):/directory /mount/point
```

**Example**

```
#mount –t nfs 192.168.3.100:/home/public /home/nfs/public
```

# Mail

**smtpclient** is a minimal SMTP client that takes an email message body and passes it on to an SMTP server. It is suitable for applications that use email to send alert messages or important logs to a specific user.

NOTE Click on the following link for more information about smtpclient:
http://www.engelschall.com/sw/smtpclient/

To send an email message, use the 'smtpclient' utility, which uses SMTP protocol. Type **`#smtpclient –help`** to see the help message.

**Example:**

```
smtpclient –s test –f sender@company.com –S IP_address receiver@company.com
< mail-body-message
```

- **`-s:`** The mail subject.
- **`-f:`** Sender's mail address
- **`-S:`** SMTP server IP address

The last mail address **receiver@company.com** is the receiver's e-mail address.
**mail-body-message** is the mail content. The last line of the body of the message should contain ONLY the period '.' character.

You will need to add your hostname to the file **/etc/hosts**.

# SNMP

The W315/325/345 has built-in SNMP V1 (Simple Network Management Protocol) agent software. It supports RFC1317 RS-232 like group and RFC 1213 MIB-II.

The following simple example allows you to use an SNMP browser on the host site to query the W315/325/345, which is the SNMP agent. The W315/325/345 will respond.

```
***** SNMP QUERY STARTED *****
        1: sysDescr.0 (octet string) Version 1.0
        2: sysObjectID.0 (object identifier) enterprises.8691.12.240
        3: sysUpTime.0 (timeticks) 0 days 03h:50m:11s.00th (1381100)
        4: sysContact.0 (octet string) Moxa Systems Co., LDT.
        5: sysName.0 (octet string) Moxa
        6: sysLocation.0 (octet string) Unknown
        7: sysServices.0 (integer) 6
        8: ifNumber.0 (integer) 6
        9: ifIndex.1 (integer) 1
        10: ifIndex.2 (integer) 2
        11: ifIndex.3 (integer) 3
        12: ifIndex.4 (integer) 4
        13: ifIndex.5 (integer) 5
        14: ifIndex.6 (integer) 6
        15: ifDescr.1 (octet string) eth0
        16: ifDescr.2 (octet string) eth1
        17: ifDescr.3 (octet string) Serial port 0
        18: ifDescr.4 (octet string) Serial port 1
        19: ifDescr.5 (octet string) Serial port 2
        20: ifDescr.6 (octet string) Serial port 3
            ...
            ...
            ...
            ...
            ...
            ...
            ...
            ...
            ...
        502: snmpInGenErrs.0 (counter) 0
        503: snmpInTotalReqVars.0 (counter) 503
        504: snmpInTotalSetVars.0 (counter) 0
        505: snmpInGetRequests.0 (counter) 0
        506: snmpInGetNexts.0 (counter) 506
        507: snmpInSetRequests.0 (counter) 0
        508: snmpInGetResponses.0 (counter) 0
        509: snmpInTraps.0 (counter) 0
        510: snmpOutTooBigs.0 (counter) 0
        511: snmpOutNoSuchNames.0 (counter) 0
        512: snmpOutBadValues.0 (counter) 0
        513: snmpOutGenErrs.0 (counter) 0
        514: snmpOutGetRequests.0 (counter) 0
        515: snmpOutGetNexts.0 (counter) 0
        516: snmpOutSetRequests.0 (counter) 0
        517: snmpOutGetResponses.0 (counter) 517
        518: snmpOutTraps.0 (counter) 0
        519: snmpEnableAuthenTraps.0 (integer) disabled(2)
***** SNMP QUERY FINISHED *****
```

NOTE Click on the following links for more information about MIB II and RS-232 like groups:
http://www.faqs.org/rfcs/rfc1213.html
http://www.faqs.org/rfcs/rfc1317.html

The W315/325/345 does NOT support SNMP trap.

# OpenVPN

OpenVPN provides two types of tunnels for users to implement VPNS: **Routed IP Tunnels** and **Bridged Ethernet Tunnels**. To begin with, check to make sure that the system has a virtual device **/dev/net/tun**. If not, issue the following command:

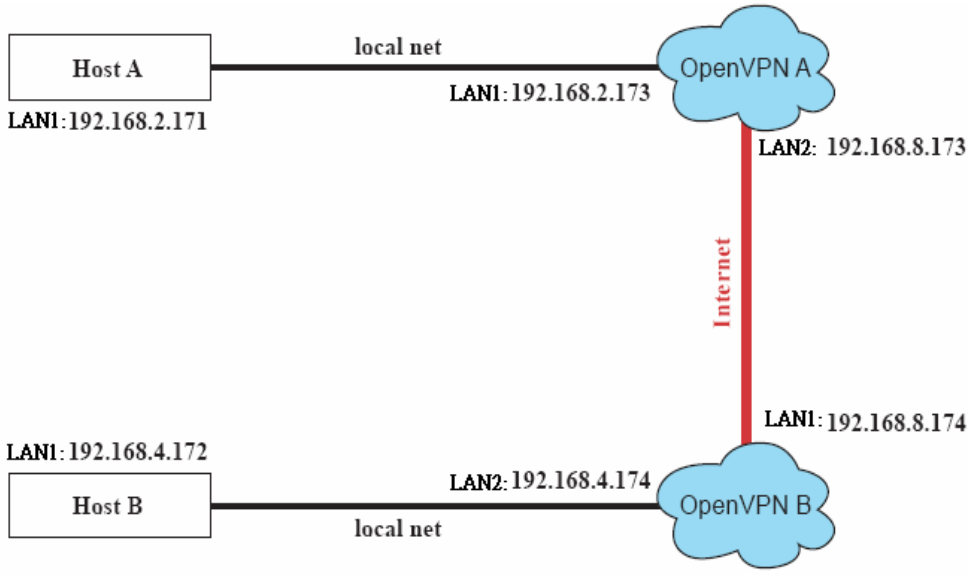
```
# mknod /dev/net/tun c 10 200
```

An Ethernet bridge is used to connect different Ethernet networks together. The Ethernets are bundled into one bigger, "logical" Ethernet. Each Ethernet corresponds to one physical interface (or port) that is connected to the bridge.

On each OpenVPN machine, you should generate a working directory, such as **/etc/openvpn**, where script files and key files reside. Once established, all operations will be performed in that directory.

## Setup 1: Ethernet Bridging for Private Networks on Different Subnets

1. Set up four machines, as shown in the following diagram.




Host A (B) represents one of the machines that belongs to OpenVPN A (B). The two remote subnets are configured for a different range of IP addresses. When this setup is moved to a public network, the external interfaces of the OpenVPN machines should be configured for static IPs, or connect to another device (such as a firewall or DSL box) first.

```
# openvpn --genkey --secret secrouter.key
```

Copy the file that is generated to the OpenVPN machine.

2. Generate a script file named **openvpn-bridge** on each OpenVPN machine. This script reconfigures interface "eth1" as IP-less, creates logical bridge(s) and TAP interfaces, loads modules, enables IP forwarding, etc.

```
#--------------------------------Start----------------------------

#!/bin/sh

iface=eth1  # defines the internal interface
maxtap=`expr 1`# defines the number of tap devices. I.e., # of tunnels

IPADDR=
NETMASK=
BROADCAST=

# it is not a great idea but this system doesn't support
# /etc/sysconfig/network-scripts/ifcfg-eth1
ifcfg_vpn()
{
while read f1 f2 f3 f4 r3
do
 if [ "$f1" = "iface" -a "$f2" = "$iface" -a "$f3" = "inet" -a "$f4" = "static" ];then
  i=`expr 0`
  while :
  do
   if [ $i -gt 5 ]; then
    break
   fi
   i=`expr $i + 1`
   read f1 f2
   case "$f1" in
    address ) IPADDR=$f2
     ;;
    netmask ) NETMASK=$f2
     ;;
    broadcast ) BROADCAST=$f2
     ;;
   esac
  done
     break
 fi
done < /etc/network/interfaces
}

# get the ip address of the specified interface
mname=
module_up()
{
oIFS=$IFS
IFS='
'
FOUND="no"
for LINE in `lsmod`
do
 TOK=`echo $LINE | cut -d' ' -f1`
 if [ "$TOK" = "$mname" ]; then
  FOUND="yes";
  break;
 fi
done
IFS=$oIFS

if [ "$FOUND" = "no" ]; then
 modprobe $mname
fi
}

start()
```

```
{
ifcfg_vpn
if [ ! \( -d "/dev/net" \) ]; then
 mkdir /dev/net
fi

if [ ! \( -r "/dev/net/tun" \) ]; then
 # create a device file if there is none
 mknod /dev/net/tun c 10 200
fi

# load modules "tun" and "bridge"
mname=tun
module_up
mname=bridge
module_up
# create an ethernet bridge to connect tap devices, internal interface
brctl addbr br0
brctl addif br0 $iface
# the bridge receives data from any port and forwards it to other ports.

i=`expr 0`
while :
do
 # generate a tap0 interface on tun
 openvpn --mktun --dev tap${i}

 # connect tap device to the bridge
 brctl addif br0 tap${i}

 # null ip address of tap device
 ifconfig tap${i} 0.0.0.0 promisc up

 i=`expr $i + 1`
 if [ $i -ge $maxtap ]; then
  break
 fi
done

# null ip address of internal interface
ifconfig $iface 0.0.0.0 promisc up

# enable bridge ip
ifconfig br0 $IPADDR netmask $NETMASK broadcast $BROADCAST

ipf=/proc/sys/net/ipv4/ip_forward
# enable IP forwarding
echo 1 > $ipf
echo "ip forwarding enabled to"
cat $ipf
}

stop() {
echo "shutdown openvpn bridge."
ifcfg_vpn
i=`expr 0`
while :
do
 # disconnect tap device from the bridge
 brctl delif br0 tap${i}
 openvpn --rmtun --dev tap${i}

 i=`expr $i + 1`
 if [ $i -ge $maxtap ]; then
  break
 fi
done
brctl delif br0 $iface
```

```
brctl delbr br0
ifconfig br0 down
ifconfig $iface $IPADDR netmask $NETMASK broadcast $BROADCAST
killall -TERM openvpn
}

case "$1" in
start)
 start
 ;;
stop)
 stop
 ;;
restart)
 stop
 start
 ;;
*)
 echo "Usage: $0 [start|stop|restart]"
 exit 1
esac
exit 0
#--------------------------------- end ----------------------------
```

Create link symbols to enable this script at boot time:

```
# ln -s /etc/openvpn/openvpn-bridge /etc/rc.d/rc3.d/S32vpn-br # for example
# ln -s /etc/openvpn/openvpn-bridge /etc/rc.d/rc6.d/K32vpn-br # for example
```

3. Create a configuration file named **A-tap0-br.conf** and an executable script file named **A-tap0-br.sh** on OpenVPN A.

```
# point to the peer
remote 192.168.8.174
dev tap0
secret /etc/openvpn/secrouter.key
cipher DES-EDE3-CBC
auth MD5
tun-mtu 1500
tun-mtu-extra 64
ping 40
up /etc/openvpn/A-tap0-br.sh
```

```
#---------------------------------Start----------------------------
#!/bin/sh
# value after "-net" is the subnet behind the remote peer
route add -net 192.168.4.0 netmask 255.255.255.0 dev br0
#--------------------------------- end ----------------------------
```

Create a configuration file named **B-tap0-br.conf** and an executable script file named **B-tap0-br.sh** on OpenVPN B.

```
# point to the peer
remote 192.168.8.173
dev tap0
secret /etc/openvpn/secrouter.key
cipher DES-EDE3-CBC
auth MD5
tun-mtu 1500
tun-mtu-extra 64
ping 40
up /etc/openvpn/B-tap0-br.sh
```

```
#--------------------------------- Start----------------------------
#!/bin/sh
# value after "-net" is the subnet behind the remote peer
route add -net 192.168.2.0 netmask 255.255.255.0 dev br0
#--------------------------------- end ----------------------------
```

**Note:** Select cipher and authentication algorithms by specifying "cipher" and "auth". To see with algorithms are available, type:

```
# openvpn --show-ciphers
# openvpn --show—auths
```

4. Start both of OpenVPN peers,

```
# openvpn --config A-tap0-br.conf&
# openvpn --config B-tap0-br.conf&
```

If you see the line "Peer Connection Initiated with 192.168.8.173:5000" on each machine, the connection between OpenVPN machines has been established successfully on UDP port 5000.

5. On each OpenVPN machine, check the routing table by typing the command:

```
# route
```

| Destination | Gateway | Genmsk | Flags | Metric | Ref | Use | Iface |
|---|---|---|---|---|---|---|---|
| 192.168.4.0 | * | 255.255.255.0 | U | 0 | 0 | 0 | br0 |
| 192.168.2.0 | * | 255.255.255.0 | U | 0 | 0 | 0 | br0 |
| 192.168.8.0 | * | 255.255.255.0 | U | 0 | 0 | 0 | eth0 |

Interface **eth1** is connected to the bridging interface **br0**, to which device **tap0** also connects, whereas the virtual device **tun** sits on top of **tap0**. This ensures that all traffic from internal networks connected to interface **eth1** that come to this bridge write to the TAP/TUN device that the OpenVPN program monitors. Once the OpenVPN program detects traffic on the virtual device, it sends the traffic to its peer.

6. To create an indirect connection to Host B from Host A, you need to add the following routing item:

```
route add –net 192.168.4.0 netmask 255.255.255.0 dev eth0
```

To create an indirect connection to Host A from Host B, you need to add the following routing item:

```
route add –net 192.168.2.0 netmask 255.255.255.0 dev eth0
```

Now ping Host B from Host A by typing:

```
ping 192.168.4.174
```

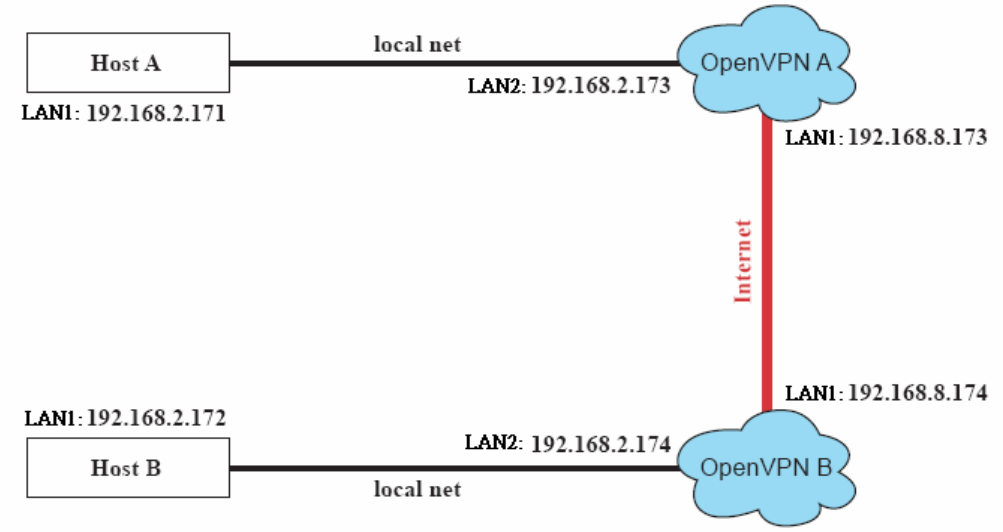
A successful ping indicates that you have created a VPN system that only allows authorized users from one internal network to access users at the remote site. For this system, all data is transmitted by UDP packets on port 5000 between OpenVPN peers.

7. To shut down OpenVPN programs, type the command:

```
# killall -TERM openvpn
```

## Setup 2: Ethernet Bridging for Private Networks on the Same Subnet

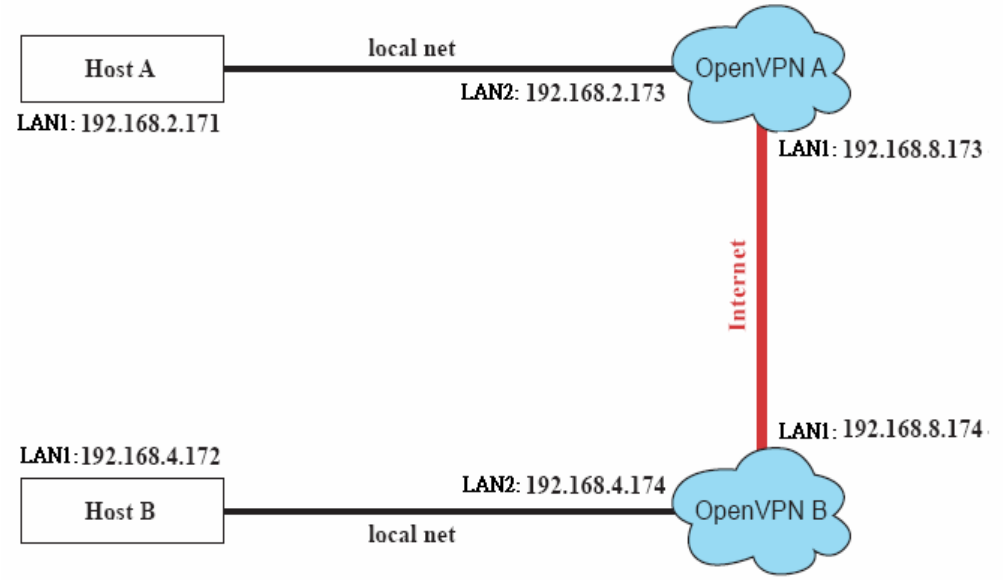
1. Set up four machines as shown in the following diagram:




2. The configuration procedure is almost the same as for the previous example. The only difference is that you will need to comment out the parameter "up" in "/etc/openvpn/A-tap0-br.conf" and "/etc/openvpn/B-tap0-br.conf".

## Setup 3: Routed IP

1. Set up four machines as shown in the following diagram:



2. Create a configuration file named "A-tun.conf" and an executable script file named "A-tun.sh".

```
# point to the peer
remote 192.168.8.174
dev tun
secret /etc/openvpn/secrouter.key
cipher DES-EDE3-CBC
auth MD5
tun-mtu 1500
tun-mtu-extra 64
ping 40
ifconfig 192.168.2.173 192.168.4.174
up /etc/openvpn/A-tun.sh
```

```
#------------------------------- Start----------------------------
#!/bin/sh
# value after "-net" is the subnet behind the remote peer
route add -net 192.168.4.0 netmask 255.255.255.0 gw $5
#------------------------------- end ----------------------------
```

Create a configuration file named **B-tun.conf** and an executable script file named **B-tun.sh** on OpenVPN B:

```
remote 192.168.8.173
dev tun
secret /etc/openvpn/secrouter.key
cipher DES-EDE3-CBC
auth MD5
tun-mtu 1500
tun-mtu-extra 64
ping 40
ifconfig 192.168.4.174 192.168.2.173
up /etc/openvpn/B-tun.sh
```

```
#------------------------------- Start----------------------------
#!/bin/sh
# value after "-net" is the subnet behind the remote peer
route add -net 192.168.2.0 netmask 255.255.255.0 gw $5
#------------------------------- end ----------------------------
```

Note that the parameter "ifconfig" defines the first argument as the local internal interface and the second argument as the internal interface at the remote peer.

Note that **$5** is the argument that the OpenVPN program passes to the script file. Its value is the second argument of **ifconfig** in the configuration file.

3. Check the routing table after you run the OpenVPN programs, by typing the command:

```
# route
```

| Destination | Gateway | Genmsk | Flags | Metric | Ref | Use | Iface |
|---|---|---|---|---|---|---|---|
| 192.168.4.174 | * | 255.255.255.255 | UH | 0 | 0 | 0 | tun0 |
| 192.168.4.0 | 192.168.4.174 | 255.255.255.0 | UG | 0 | 0 | 0 | tun0 |
| 192.168.2.0 | * | 255.255.255.0 | U | 0 | 0 | 0 | eth1 |
| 192.168.8.0 | * | 255.255.255.0 | U | 0 | 0 | 0 | eth0 |

# 5

# Development Tool Chains

This chapter describes how to install a tool chain in the host computer that you use to develop your applications. In addition, the process of performing cross-platform development and debugging are also introduced. For clarity, the W315/325/345 embedded computer is called a target computer.

The following functions are covered in this chapter:

- **Linux Tool Chain**
  - Steps for Installing the Linux Tool Chain
  - Compilation for Applications
  - On-Line Debugging with GDB

# Linux Tool Chain

The Linux tool chain contains a suite of cross compilers and other tools, as well as the libraries and header files that are necessary to compile your applications. These tool chain components must be installed in your host computer (PC) running Linux. We have confirmed that the following Linux distributions can be used to install the tool chain.

**Fefora core 1 & 2.**

## Steps for Installing the Linux Tool Chain

The tool chain needs about 485 MB of hard disk space. To install it, follow the steps.

1. Insert the package CD into your PC and then issue the following commands:
   ```
   #mount /dev/cdrom /mnt/cdrom
   #sh /mnt/cdrom/tool-chain/linux/install.sh
   ```
2. Wait for the installation process to complete. This should take a few minutes.
3. Add the directory **/usr/local/arm-linux/bin** to your path. You can do this for the current login by issuing the following commands:
   ```
   #export PATH="/usr/local/arm-linux/bin:$PATH"
   ```
   Alternatively, you can add the same commands to **$HOME/.bash_profile** to make it effective for all login sessions.

## Compilation for Applications

To compile a simple C application, use the cross compiler instead of the regular compiler:

```
#arm-linux-gcc  –o example –Wall –g –O2 example.c
#arm-linux-strip  –s example
#arm-linux-gcc  -ggdb –o example-debug example.c
```

Most of the cross compiler tools are the same as their native compiler counterparts, but with an additional prefix that specifies the target system. In the case of x86 environments, the prefix is **`i386-linux-`** and in the case of IA204/241 ARM boards, it is **`arm-linux-`**.

For example, the native C compiler is **`gcc`** and the cross C compiler for ARM in the W315/325/345 is **`arm-linux-gcc.`**

The following cross compiler tools are provided:

| | |
|---|---|
| ar | Manages archives (static libraries) |
| as | Assembler |
| c++, g++ | C++ compiler |
| cpp | C preprocessor |
| gcc | C compiler |
| gdb | Debugger |
| ld | Linker |
| nm | Lists symbols from object files |
| objcopy | Copies and translates object files |
| objdump | Displays information about object files |
| ranlib | Generates indexes to archives (static libraries) |
| readelf | Displays information about ELF files |

| | |
|---|---|
| size | Lists object file section sizes |
| strings | Prints strings of printable characters from files (usually object files) |
| strip | Removes symbols and sections from object files (usually debugging information) |

## On-Line Debugging with GDB

The tool chain also provides an on-line debugging mechanism to help you develop your program. Before performing a debugging session, add the option **-ggdb** to compile the program. A debugging session runs on a client-server architecture on which the server **`gdbserver`** is installed int the targe computer and the client **ddd** is installed in the host computer. We'll asuumne that you have uploaded a program named **hello-debug** to the target computer and strat to debug the program.

1. Log on to the target computer and run the debugging server program.

   ```
   #gdbserver 192.168.4.142:2000 hello-debug
   Process hello-debug created; pid=38
   ```

   The debugging server listens for connections at network port 2000 from the network interface 192.168.4.142. The name of the program to be debugged follows these parameters. For a program requiring arguments, add the arguments behind the program name.

2. In the host computer, change the directory to where the program source resides**.**

   ```
   cd /my_work_directory/myfilesystem/testprograms
   ```

3. Execute the client program.

   ```
   #ddd --debugger arm-linux-gdb hello-debug &
   ```

4. Enter the following command at the GDB, DDD command prompt.

   ```
   Target remote 192.168.4.99:2000
   ```

   The command produces a line of output on the target console, similar to the following.

   ```
   Remote debugging using 192.168.4.99:2000
   ```

   192.168.4.99 is the machine's IP address, and 2000 is the port number. You can now begin debugging in the host environment using the interface provided by DDD.

5. Set a break point on main by double clicking, or by entering **`b main`** on the command line.
6. Click the **cont** button.

# 6

# Programmer's Guide

This chapter includes important information for programmers.

The following functions are covered in this chapter:

- **Before Programming Your Embedded System**
  - Caution Required when Using File Systems
  - Using a RAM File System instead of a Flash File System
- **Flash Memory Map**
- **Device API**
- **RTC (Real Time Clock)**
- **Buzzer**
- **WDT (Watch Dog Timer)**
- **UART**
- **Relay Output (W345 only)**

# Before Programming Your Embedded System

## Caution Required when Using File Systems

We recommend that you only store your programs on the on-board NOR Flash. The log data generated by your programs should be stored on an external storage device, such as an SD card or Network File System. Note that a Network File System will generally provide the largest amount of storage space. In addition, it is easier to replace a full or damaged SD card than an on-board NOR Flash.

A NOR Flash has a life cycle of 100,000 write operations in the block (128 KB) level, but does not support BBM (Bad Block Management). An SD card also has a life cycle, but most SD cards are made from a NAND Flash, for which the hardware controllers implement BBM. This feature allows FAT to skip bad blocks if they exist. Furthermore, the memory space of an SD card is much larger than that of the NOR Flash. Cautiously utilizing this space will ensure that its life cycle will not be exceeded. When creating a file for storing log data, we suggest setting up your program to create a large empty file (e.g., 30 MB), and then write data evenly over the space. When reaching the end of the space, the program rewinds the write operations. As a result, the number of write operations on each block will be reduced.

## Using a RAM File System instead of a Flash File System

Although data in the RAM file system will be wiped out after a power off, this file system has several advantages over a Flash file system. The RAM file system includes faster read/write access, and has no life cycle issues.

For timely and/or important applications that relay data directly back to the host, you should write the necessary log data to the RAM file system. After the host accesses the data, the application will erase the data to free up the space for further uses.

The embedded computer has limited resources, and for this reason, designers should determine if storing data in a file system is really necessary. If it is necessary, then be sure to choose the most appropriate file system for your application.

# Flash Memory Map

Partition sizes are hard coded into the kernel binary. To change the partition sizes, you will need to rebuild the kernel. The flash memory map is shown in the following table.

| Address | Size | Contents |
|---|---|---|
| 0x00000000 – 0x0003FFFF | 256 KB | Boot Loader—Read ONLY |
| 0x00040000 – 0x001FFFFF | 1.8 MB | Kernel object code—Read ONLY |
| 0x00200000 – 0x009FFFFF | 8 MB | Root file system (JFFS2) —Read ONLY |
| 0x00A00000 – 0x00FFFFFF | 6 MB | User directory (JFFS2) —Read/Write |

# Device API

The W315/325/345 supports control devices with the **ioctl** system API. You will need to **`include <moxadevice.h>`**, and use the following **ioctl** function.

```
int ioctl(int d, int request,…);
 Input: int d  - open device node return file handle
 int request – argument in or out
```

Use the desktop Linux's man page for detailed documentation:

```
#man ioctl
```

# RTC (Real Time Clock)

The device node is located at **/dev/rtc**. The W315/325/345 supports Linux standard simple RTC control. You must **`include <linux/rtc.h>`**.

1. Function: RTC_RD_TIME

   **`int ioctl(fd, RTC_RD_TIME, struct rtc_time *time);`**

   Description: read time information from RTC. It will return the value on argument 3.

2. Function: RTC_SET_TIME

   **`int ioctl(fd, RTC_SET_TIME, struct rtc_time *time);`**

   Description: set RTC time. Argument 3 will be passed to RTC.

# Buzzer

The device node is located at **/dev/console**. The W315/325/345 supports Linux standard buzzer control, with the W315/325/345's buzzer running at a fixed frequency of 100 Hz. You must **`include <sys/kd.h>`**.

Function: KDMKTONE

**`ioctl(fd, KDMKTONE, unsigned int arg);`**

Description: The buzzer's behavior is determined by the argument **`arg`**. The "high word" part of arg gives the length of time the buzzer will sound, and the "low word" part gives the frequency.

The buzzer's on / off behavior is controlled by software. If you call the "ioctl" function, you MUST set the frequency at 100 Hz. If you use a different frequency, the system could crash.

# WDT (Watch Dog Timer)

**1. Introduction**

The WDT works like a watch dog function. You can enable it or disable it. When the user enables WDT but the application does not acknowledge it, the system will reboot. You can set the acknowledgement time from a minimum of 50 msec to a maximum of 60 seconds.

**2. How the WDT works**

The WDT function is disabled when the system boots up. The user application can also enable acknowledgement. When the user does not acknowledge, it will let the system reboot.

Kernel boot
…..
….
User application running and enable user acknowledgement
….
….

**3. The user API**

The user application must **`include <moxadevic.h>`**, and **`link moxalib.a`**. A makefile example is shown below:

```
all:
  arm-linux-gcc –o xxxx  xxxx.c -lmoxalib
```

**int swtd_open(void)**

| | |
|---|---|
| **Description:** | Open the file handle to control the WDT. If you want to do something you must first to this. And keep the file handle to do other. |
| **Input:** | None |
| **Output:** | The return value is file handle. If has some error, it will return < 0 value. You can get error from errno(). |

**int swtd_enable(int fd, unsigned long time)**

| | |
|---|---|
| **Description:** | Enable application WDT And you must do ack after this process. |
| **Input:** | int fd - the file handle, from the swtd_open() return value.<br>unsigned long time - The time you wish to ack sWatchDog periodically. You must ack the WDT before timeout. If you do not ack, the system will reboot automatically. The minimal time is 50 msec, the maximum time is 60 seconds. The time unit is msec. |
| **Output:** | OK will be zero. The other has some error, to get the error code from errno(). |

**int swtd_disable(int fd)**

| | |
|---|---|
| **Description:** | Disable the application to acknowledge WDT. And the kernel will it. User does not to do it at periodic. |
| **Input:** | int fd - the file handle from swtd_open() return value. |
| **Output:** | OK will be zero. The other has some error, to get error code from errno. |

**int swtd_get(int fd, int *mode, unsigned long *time)**

| | |
|---|---|
| **Description:** | Get current setting values. mode –1 for user application enable WDT: need to acknowledge. 0 for user application disable WDT: does not need to acknowledge. time – The time period to acknowledge WDT. |
| **Input :** | int fd - the file handle from swtd_open() return value. int mode - the function will return the status of user application need to . unsigned long time – the function will return the current time period. |
| **Output:** | OK will be zero. The other has some error, to get error code from errno(). |

**int swtd_ack(int fd)**

| | |
|---|---|
| **Description:** | Acknowledge sWatchDog. When the user application enable sWatchDog. It need to call this function periodically with user predefined time in the application program. |
| **Input:** | int fd - the file handle from swtd_open() return value. |
| **Output:** | OK will be zero. The other has some error, to get error code from errno(). |

**int swtd_close(int fd)**

| | |
|---|---|
| **Description:** | Close the file handle. |
| **Input:** | int fd - the file handle from swtd_open() return value. |
| **Output:** | OK will be zero. The other has some error, to get error code from errno(). |

**4. Special Note**

When you "kill the application with -9" or "kill without option" or "Ctrl+c" the kernel will change to auto ack the sWatchDog.

When your application enables the sWatchDog and does not ack, your application may have a logical error, or your application has made a core dump. The kernel will not change to auto ack. This can cause a serious problem, causing your system to reboot again and again.

**5. User application example**

**Example 1:**

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <moxadevice.h>

int main(int argc, char *argv[])
{
  int  fd;

  fd = swtd_open();
  if ( fd < 0 ) {
   printf("Open sWatchDog device fail !\n");
   exit(1);
  }
  swtd_enable(fd, 5000); // enable it and set it 5 seconds
  while ( 1 ) {
   // do user application want to do
   …..
   ….
   swtd_ack(fd);
   …..
   ….
  }
  swtd_close(fd);
  exit(0);
}
```

The makefile is shown below:

```
all:
  arm-linux-gcc –o xxxx xxxx.c –lmoxalib
```

**Example 2:**

```
#include <stdio.h>
#include <stdlib.h>
#include <signal.h>
#include <string.h>
#include <sys/stat.h>
#include <sys/ioctl.h>
#include <sys/select.h>
#include <sys/time.h>
#include <moxadevice.h>

static void mydelay(unsigned long msec)
{
  struct timeval time;

  time.tv_sec = msec / 1000;
  time.tv_usec = (msec % 1000) * 1000;
  select(1, NULL, NULL, NULL, &time);
}
```

```
static int swtdfd;
static int stopflag=0;

static void stop_swatchdog()
{
 stopflag = 1;
}

static void do_swatchdog(void)
{
 swtd_enable(swtdfd, 500);
 while ( stopflag == 0 ) {
  mydelay(250);
  swtd_ack(swtdfd);
 }
 swtd_disable(swtdfd);
}

int main(int argc, char *argv[])
{
 pid_t  sonpid;

 signal(SIGUSR1, stop_swatchdog);
 swtdfd = swtd_open();
 if ( swtdfd < 0 ) {
  printf("Open sWatchDog device fail !\n");
  exit(1);
 }
 if ( (sonpid=fork()) == 0 )
  do_swatchdog();
 // do user application main function
 …..
 …..
 …..
 // end user application
 kill(sonpid, SIGUSR1);
 swtd_close(swtdfd);
 exit(1);
}
```

The makefile is shown below:

```
all:
 arm-linux-gcc –o xxxx xxxx.c –lmoxalib
```

# UART

The normal tty device node is located at **/dev/ttyM0 … ttyM3**.

The W315/325/345 supports Linux standard termial control. The Moxa UART Device API allows you to configure ttyM0 to ttyM3 as RS-232, RS-422, 4-wire RS-485, or 2-wire RS-485. W315/325/345 supports RS-232, RS-422, 2-wire RS-485, and 4-wire RS-485.

You must **include <moxadevice.h>**.

```
#define RS232_MODE   0
#define RS485_2WIRE_MODE 1
#define RS422_MODE   2
#define RS485_4WIRE_MODE 3
```

1. Function: MOXA_SET_OP_MODE

   ```
   int ioctl(fd, MOXA_SET_OP_MODE, &mode)
   ```

   **Description**
   Set the interface mode. Argument 3 mode will pass to the UART device driver and change it.

2. Function: MOXA_GET_OP_MODE

```
int ioctl(fd, MOXA_GET_OP_MODE, &mode)
```

**Description**
Get the interface mode. Argument 3 mode will return the interface mode.

There are two Moxa private ioctl commands for setting up special baudrates.

Function: MOXA_SET_SPECIAL_BAUD_RATE
Function: MOXA_GET_SPECIAL_BAUD_RATE

If you use this ioctl to set a special baudrate, the termios cflag will be B4000000, in which case the B4000000 define will be different. If the baudrate you get from termios (or from calling tcgetattr()) is B4000000, you must call ioctl with MOXA_GET_SPECIAL_BAUD_RATE to get the actual baudrate.

## Example to set the baudrate

```
#include <moxadevice.h>
#include <termios.h>
struct termios term;
int  fd, speed;
fd = open("/dev/ttyM0", O_RDWR);
tcgetattr(fd, &term);
term.c_cflag &= ~(CBAUD | CBAUDEX);
term.c_cflag |= B4000000;
tcsetattr(fd, TCSANOW, &term);
speed = 500000;
ioctl(fd, MOXA_SET_SPECIAL_BAUD_RATE, &speed);
```

## Example to get the baudrate

```
 #include <moxadevice.h>
 #include <termios.h>
 struct termios term;
 int  fd, speed;
 fd = open("/dev/ttyM0", O_RDWR);
 tcgetattr(fd, &term);
if ( (term.c_cflag & (CBAUD|CBAUDEX)) != B4000000 )
{// follow the standard termios baud rate define} else
{ioctl(fd, MOXA_GET_SPECIAL_BAUD_RATE, &speed);}
```

## Baudrate error

Divisor = 921600/Target Baud Rate. (Only Integer part)
ENUM = 8 * (921600/Targer - Divisor) ( Round up or down)
Inaccuracy = (Target Baud Rate – 921600/(Divisor + (ENUM/8))) * 100%

E.g.,

To calculate 500000 bps
Divisor = 1, ENUM = 7,
Error = 1.7%
*The error should less than 2% for reliable data transmission.

## Special Note

1. If the target baudrate is not a special baudrate (e.g. 50, 75, 110, 134, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600), the termios cflag will be set to the same flag.
2. If you use stty to get the serial information, you will get speed equal to 0.

# Relay Output (W345 only)

The W345 uses a DO (digital ouput) for relay output. Programming with the following API allows you to change the state of the digital output and to get the current state of the digital output.

## User API

**int set_dout_state(int doport, int state)**

| | |
|---|---|
| **Description:** | Set the state of digital ouput. |
| **Input :** | int doport - the port number of digital output. It ranges from 0 to 3.<br>int state - the output state, high or low. You can use defined constant DIO_HIGH or DIO_LOW. |
| **Output:** | 0 |

**int get_dout_state(int doport, int *state)**

| | |
|---|---|
| **Description:** | Get the current state of digital output. |
| **Input :** | int doport - the port number of digital output. It ranges from 0 to 3. int state - the current state of digital output. |
| **Output:** | 0 |

## Special Note

Don't forget to link the library libmoxalib & libpthread for DO programming, and also include the header file moxadevice.h. The DO library only can be used by one program at a time.

## Example

File Name: tdio.c

Description: The program indicates how to control DO.

```
#include <stdio.h>
#include <stdlib.h>
#include <moxadevice.h>
#include <fcntl.h>

#ifdef DEBUG
#define dbg_printf(x...) printf(x)
#else
#define dbg_printf(x...)
#endif

#define MIN_DURATION 40

static char *DataString[2]={"Low  ", "High "};
static void hightolowevent(int diport)
{
 printf("\nDIN port %d high to low.\n", diport);
}

static void lowtohighevent(int diport)
{
 printf("\nDIN port %d low to high.\n", diport);
}

int main(int argc, char * argv[])
{
 int i, j, state, retval;
 unsigned long duration;
```

```
 while( 1 ) {
  printf("\nSelect a number of menu, other key to exit.\n\
 1. get now state.      \n\
 2. set high state.     \n\
 3. set low state.      \n\
 4. quit           \n\
Choose : ");
 retval =0;
  scanf("%d", &i);
  } else if ( i == 1 ) {// get now data
   printf("DOUT data : ");
   get_dout_state(0, &state);
   printf("%s", DataString[state]);
   printf("\n");
  } else if ( i == 2 ) {// set high data
   retval=set_dout_state(0, 1);
  } else if ( i == 3 ) {// set low data
   retval=set_dout_state(0, 0);
  } else if ( i == 4 ) {// quit
   break;
  } else {
   printf("Select error, please select again !\n");
  }

  switch(retval) {
    case DIO_ERROR_PORT:
     printf("DIO error port\n");
     break;
    case DIO_ERROR_MODE:
     printf("DIO error mode\n");
     break;
    case DIO_ERROR_CONTROL:
     printf("DIO error control\n");
     break;
    case DIO_ERROR_DURATION:
     printf("DIO error duratoin\n");
    case DIO_ERROR_DURATION_20MS:
     printf("DIO error! The duratoin is not a multiple of 20 ms\n");
     break;
  }
 }

 return 0;
}
```

# 7

# Software Lock

"Software Lock" is an innovative technology developed by Moxa's engineers. It can be adopted by a system integrator or developer to protect applications from being copied. An application is compiled into a binary format bound to the embedded computer and the operating system (OS) that the application runs on. As long as one obtains it from the computer, he/she can install it into the same hardware and the same operating system. The add-on value created by the developer is thus lost.

Moxa's engineers developed this protection mechanism for your applications using data encryption. The binary file associated with each of your applications needs to undergo an additional encryption process after you have developed it. The process requires you to install an encryption key in the target computer.

1. Choose an encryption key (e.g.,"ABigKey") and install it in the target computer by a pre-utility program, 'setkey'.

   **#setkey ABigKey**

   Note: set an empty string to clear the encryption key in the target computer by:

   **#setkey ""**

2. Develop and compile your program in the development PC.
3. In the development PC, run the utility program 'binencryptor' to encrypt your program with an encryption key.

   **#binencryptor yourProgram ABigKey**

4. Upload the encrypted program file to the target computerby FTP or NFS and test the program.

The encryption key is a computer-wise key. That is, a computer has only one key installed. Running the program 'setkey' multiple times causes the key to be overidden.

To prove the effectiveness of this software protection mechanism, prepare a target computer that has not installed an encryption key, or install a key different from that used to encrypt your program. In any case, the encrypted program will fail immediately.

This mechanism also allows a computer with an encryption key to bypass programs that are not encrypted. Therefore, in the development phase, you can develop your programs and test them cleanly in the target computer.

NOTE You may get the following error messages when:

1. You try to run an encrypted program on an embedded computer without having encryption key installed.

   Error =>
   **Inconsistency detected by ld.so: dynamic-link.h: 62: elf_get_dynamic_info: Assertion `! "bad dynamic tag"' failed!**

2. you try to run an encrypted program on an embedded computer having different encryption key installed.

   Error =>
   **Segmentation fault**

# A

# System Commands

## Linux normal command utility collection

### File manager

| | | |
|---|---|---|
| 1. | **cp** | **copy file** |
| 2. | **ls** | **list file** |
| 3. | **ln** | **make symbolic link file** |
| 4. | **mount** | **mount and check file system** |
| 5. | **rm** | **delete file** |
| 6. | **chmod** | **change file owner & group & user** |
| 7. | **chown** | **change file owner** |
| 8. | **chgrp** | **change file group** |
| 9. | **sync** | **sync file system, let system file buffer be saved to hardware** |
| 10. | **mv** | **move file** |
| 11. | **pwd** | **display now file directly** |
| 12. | **df** | **list now file system space** |
| 13. | **mkdir** | **make new directory** |
| 14. | **rmdir** | **delete directory** |

### Editor

| | | |
|---|---|---|
| 1. | **vi** | **text editor** |
| 2. | **cat** | **dump file context** |
| 3. | **zcat** | **compress or expand files** |
| 4. | **grep** | **search string on file** |
| 5. | **cut** | **get string on file** |
| 6. | **find** | **find file where are there** |
| 7. | **more** | **dump file by one page** |
| 8. | **test** | **test file exist or not** |
| 9. | **sleep** | **sleep (seconds)** |
| 10. | **echo** | **echo string** |

### Network

| | | |
|---|---|---|
| 1. | **ping** | **ping to test network** |
| 2. | **route** | **routing table manager** |
| 3. | **netstat** | **display network status** |
| 4. | **ifconfig** | **set network ip address** |
| 5. | **tracerout** | **trace route** |
| 6. | **telnet** | **teletype network** |
| 7. | **ftp** | **file transfer protocol** |

## Process

| | | |
|---|---|---|
| **1.** | **kill** | **kill process** |
| **2.** | **ps** | **display now running process** |

## Other

| | | |
|---|---|---|
| **1.** | **dmesg** | **dump kernel log message** |
| **2.** | **sty** | **to set serial port** |
| **3.** | **zcat** | **dump .gz file context** |
| **4.** | **mknod** | **make device node** |
| **5.** | **free** | **display system memory usage** |
| **6.** | **date** | **print or set the system date and time** |
| **7.** | **env** | **run a program in a modified environment** |
| **8.** | **clear** | **clear the terminal screen** |
| **9.** | **reboot** | **reboot / power off/on the server** |
| **10.** | **halt** | **halt the server** |
| **11.** | **du** | **estimate file space usage** |
| **12.** | **gzip, gunzip** | **compress or expand files** |
| **13.** | **hostname** | **show system's host name** |

## Moxa special utilities

| | | |
|---|---|---|
| **1.** | **kversion** | **show kernel version** |
| **2.** | **cat /etc/version** | **show user directory version** |
| **3.** | **upramdisk** | **mount ramdisk** |
| **4.** | **downramdisk** | **unmount ramdisk** |